

**ALTERNATIVE REMEDIAL
CONTRACTING STRATEGY PROGRAM**

**SAMPLING AND ANALYSIS PLAN
NORTH PENN AREA 12**

EPA CONTRACT NO: 68-W8-0090
EPA WORK ASSIGNMENT NO.: 36-3LW5.0
CH2M HILL PROJECT NO.: MAE63149.PP.QS
JULY 1994

Prepared for:

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July 1994

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SITE RI/FS

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CH2M HILL's Designated QC Officer _____ Date _____

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**NORTH PENN AREA 12
REMEDIAL INVESTIGATION
AND FEASIBILITY STUDY**

**QUALITY ASSURANCE PROJECT PLAN
(QAPP)**

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Preface

The Sampling and Analysis Plan (SAP) is written for the field activities to be conducted as part of the remedial investigation and feasibility study (RI/FS) at the North Penn Area 12 site in Montgomery County, Pennsylvania. The RI/FS is being performed by CH2M HILL for the United States Environmental Protection Agency (EPA) Region III under Work Assignment Number 36-3LW5 and EPA Contract Number 68-W8-0090. The SAP consists of three parts:

1. The Quality Assurance Project Plan (QAPP)—The QAPP describes the policy, organization, functional activities, and quality assurance and quality control protocols necessary to achieve Data Quality Objectives (DQOs) as dictated by the intended use of the data.
2. The Field Sampling Plan (FSP)—The FSP provides guidance for all fieldwork by defining in detail the sampling and data-gathering methods to be used during field activities.
3. The Health and Safety Plan (HSP)—The HSP for the field effort describes CH2M HILL's health and safety program for field activities. The HSP identifies potentially hazardous operations and exposures and prescribes appropriate protective measures.

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LIST OF ACRONYMS AND ABBREVIATIONS

ARARs	applicable or relevant and appropriate requirements
ARCS	Alternative Remedial Contracting Strategy
ASM	ARCS sample manager
BNA	base neutral/acid compounds
BOD	biochemical oxygen demand
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFC	Chlorofluorohydrocarbon
CLP	Contract Laboratory Program
COD	chemical oxygen demand
CPMS	Contract Program Management Section
CRL	Central Regional Laboratory
DAS	delivery of analytical services
DQO	data quality objective
DV	data validator
EA	environmental assessment
EPA	United States Environmental Protection Agency
ERRIS	Emergency and Remedial Response Information System
ERM	Environmental Resources Management, Inc.
ERT	Emergency Response Team
FC	field coordinator
FS	feasibility study
FSP	field sampling plan
GC	gas chromatograph
HEAST	Health Effects Summary Tables
HSP	health and safety plan
IRIS	Integrated Risk Information System
LOE	level of effort
MSL	mean sea level

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	operation and maintenance
PA	preliminary assessment
PaDER	Pennsylvania Department of Environmental Resources
PAH	polycyclic aromatic hydrocarbon
PCBs	polychlorinated biphenyls
PCE	perchloroethene
PHE	public-health evaluation
PPE	personal protective equipment
PRP	potentially responsible party
PVC	polyvinyl chloride
QA	quality assurance
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
QC	quality control
RAS	routine analytical services
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	remedial investigation
RI/FS	remedial investigation and feasibility study
ROD	record of decision
RPD	relative percent difference
RPM	remedial project manager
RPOC	regional point of contact

LIST OF ACRONYMS AND ABBREVIATIONS
(continued)

RSCC	Regional Sample Control Center
RSD	relative standard deviation
RTL	review team leader
SAMLCWOA	Superfund Analytical Methods for Low Concentration Water for Organic Analysis
SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act
SI	site inspection
SM	site manager
SMO	Sample Management Office
SOP	standard operating procedure
SVE	soil-vapor extraction
SVOC	semivolatile organic compound
TAL	Target Analyte List
TAL/CN	TAL including cyanide
TBC	to be considered
TCA	1,1,1-trichloroethane
TCE	trichloroethene
TCL	Target Compound List
TCLP	toxic compounds leaching potential
TDS	total dissolved solids
TIC	tentatively identified compound
TIE	toxicity identification evaluation
TSS	total suspended solids
USGS	United States Geological Survey
VOC	volatile organic compound

Section 1 Introduction

Environmental Protection Agency (EPA) policy requires all Alternative Remedial Contracting Strategy (ARCS) activities to be under the control of a centrally managed quality assurance (QA) program as stated in the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, October 1988, for hazardous waste site investigations. This requirement applies to all environmental monitoring and measurement efforts mandated by or supported by EPA.

Each investigator is responsible for implementing procedures to determine that the precision, accuracy, completeness, representativeness, and comparability of the data collected are known and documented. In addition, the investigator should specify acceptable quality levels for data. To meet this responsibility uniformly, each investigator must have a written QA Project Plan (QAPP) covering each project to be investigated.

The QAPP, prepared by EPA Region III and its contractor, presents, in specific terms, the policies, objectives, organization, functional activities, and QA and quality control (QC) activities designed to achieve the data quality goals of the specific project. Where possible, existing QA/QC guidelines, policies, programs, and other specifics are incorporated into the QAPP by reference.

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Section 2 Project Description

Project Background

The North Penn Area 12 site occupies approximately 50 acres at 1547 Trooper Road, Worcester Township, Montgomery County, Pennsylvania. The site location is shown in Figure 2-1.

The site was most recently (since 1987) operated by Transcoil Incorporated, a subsidiary of Eagle-Picher Industries, which manufactured electric motors at the site. The industrial history of the site dates to 1952. Prior to 1952, the property was operated as a horse farm.

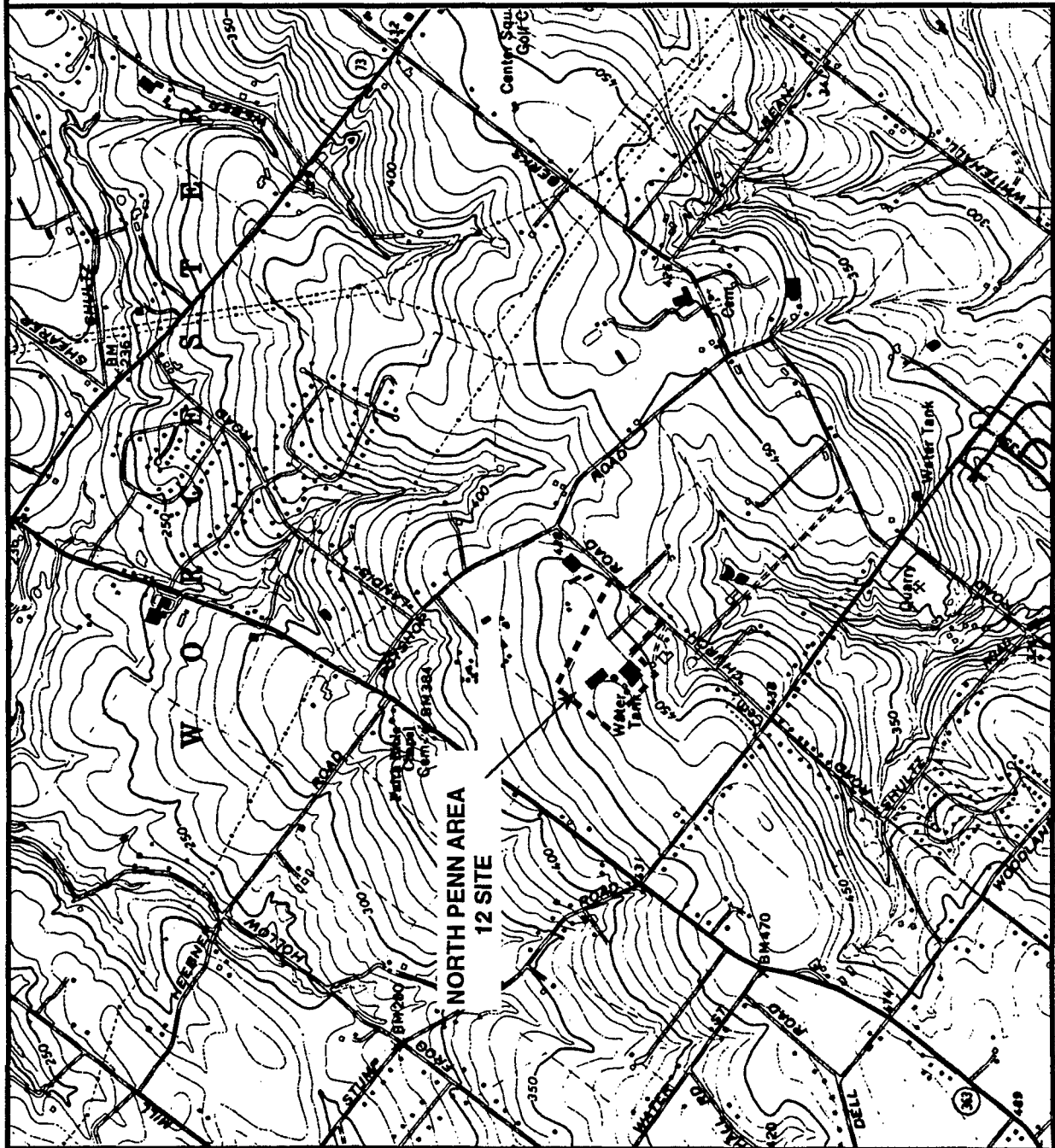
Various environmental investigations have been conducted at the site beginning in 1979 when the Pennsylvania Department of Environmental Resources (PaDER) identified the facility as a potential source of trichloroethene (TCE) and 1,1,1-trichloroethane (TCA) in the onsite and offsite groundwater.

The site was proposed for inclusion on the National Priorities List (NPL) in 1987 as a result of these investigations. In 1989, Transcoil/Eagle-Picher, the potentially responsible party (PRP) voluntarily entered into a consent agreement with EPA to take the lead in conducting an RI/FS at the site. The PRP contracted Environmental Resources Management, Inc. (ERM) of Exton, Pennsylvania, to perform this work. A final RI/FS work plan was submitted by ERM to Region III on May 18, 1990, and was subsequently approved and work commenced.

RI/FS activities halted on January 7, 1991, when Eagle-Picher filed for relief under Chapter 11 of the bankruptcy code. At the time of this filing, field investigation activities pertaining to the RI/FS were in progress and no final or draft documents had been submitted or prepared.

In accordance with the consent agreement, the Chapter 11 filing resulted in the Transcoil site becoming a federal-lead Superfund site. Region III took over the site and assigned the task of completing the RI/FS activities to CH2M HILL under the previously referenced contract and work assignment.

The purpose of the RI is to complete the previously initiated RI/FS in a manner consistent with the EPA-approved PRP's RI/FS work plan. This approach was dictated by EPA in the August 7, 1991, Statement of Work to CH2M HILL.



Source: USGS 7.5 minute Quadrangle Map
(Lansdale, PA)

0 1000 2000
Scale in Feet

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Section 2.0 of the PRP's final work plan, presented in Appendix A of this document, provides a discussion on the site background, description, and results of previous investigations. Section 2.1 discusses the site location and history. Section 2.2 summarizes previous investigations. A discussion on the physical characteristics of the site including the geology, hydrogeology, and groundwater quality, in addition to information on suspected source areas and potential receptors are presented in Section 2.3.

Table 2-1 presents the contaminants of potential concern at the North Penn Area 12 site based on the available data. At this preliminary stage, a conservative approach was used to create this list. All organic chemicals that have been definitively identified are included, as well as inorganic chemicals that have been measured at concentrations that appear to be above normal background or at concentrations that may pose a human health risk. This list may be expanded or reduced as more data are gathered during the RI.

Table 2-1 CONTAMINANTS OF POTENTIAL CONCERN AT THE NORTH PENN AREA 12 SITE	
Organic Chemicals	Inorganic Chemicals
Trichloroethene (TCE) 1,1,1-Trichloroethane (TCA) Freon-113 1,1-Dichloroethene Vinyl chloride bis(2-Ethylhexyl)phthalate	Arsenic Beryllium

The data gaps that need to be addressed to complete the RI/FS have been identified by reviewing the work previously performed at the site by the PRP, conducting a preliminary risk assessment, identifying potential applicable or relevant and appropriate requirements (ARARs), and performing a preliminary scoping of remedial technologies.

Project Objectives

The overall objective of this project is to conduct an RI/FS consistent with, and meeting the requirements of, the statutes, regulations, and EPA guidance noted in this section. The specific objectives of the RI/FS at the North Penn Area 12 site have been tailored to account for site-specific characteristics and the unique nature of the site. The general objectives are listed below.

- Define the nature and extent of soil contamination at the site.
- Define the source, nature, and extent of groundwater contamination and the actual and potential pathways for contaminant migration at the site.
- Identify existing and potential environmental and human exposure points to contaminants at the site.
- Perform an assessment of the risks to human health and to the environment.
- Identify and evaluate remedial alternatives for the site.

QAPP Objectives

The QAPP specifies procedures to obtain precise, accurate, complete, representative, and comparable samples and sample results and also specifies sampling and analytical procedures that will permit identification of the compounds of concern.

Scope of Field Activities

The field investigation at the North Penn Area 12 site will encompass the following sampling and analysis activities:

- **Residential Well Sampling:** The residential well sampling will be done to evaluate the current position and movement of the contaminant plume especially with respect to residences not previously sampled but in the vicinity of residences with detectable concentrations, TCE, and residences sampled 2 years that have not received carbon units. Samples from a total of 71 houses will be collected and analyzed for: low-level volatile compounds as described in Superfund Analytical Methods for Low Concentration Water for Organic Analysis (SAMLCWOA) 10,92, and 1,1,12-trichloro, 1,2,2-trifluoroethane (Freon 113). Currently there are no indications of other types of contaminants of concern, such as semivolatile organic compounds, pesticides/polychlorinated biphenyls (PCBs), or inorganics, present in the groundwater caused by releases from the Transcoil site. CH2M HILL proposes to analyze samples from onsite wells for the complete suite of Target Compound List (TCL) and Target Analyte List (TAL) parameters. If additional contaminants of concern are identified, future rounds of residential well sampling will be modified to address those compounds. The locations are shown in Figure 2-5 of the FSP.

- **Soil Sampling:** Samples will be collected at an estimated 13 soil boring locations to be drilled on the Transicoil property and the neighboring Hitchens property, and an estimated 45 boring locations on the former Nike Missile Battery Control Area. Twelve-inch samples will be collected for every 2 feet of soil. Each of the borings will be advanced to hydraulic probe refusal, estimated to be 10 feet. See Table 2-2 for details.

Selected soil samples, an estimated two per boring, will be analyzed for selected volatile organic compounds (VOCs) in an onsite laboratory. The soil samples will be screened by using an OVM. The two samples that produce the highest OVM reading in each borehole will be selected for analysis in the onsite laboratory. If all OVM readings are nondetect, the first sample will be collected from within the first 3 feet in the borehole, and the second sample will be collected from the approximate middle of the boring. Samples will be chosen preferentially for analysis if abnormal staining, odor, or some other information suggests a sample may be contaminated. The onsite laboratory will be provided by the soil sampling subcontractor. Standard operating procedures (SOPs) will be provided if requested by EPA, after the subcontractor has been contracted. The selected VOCs are TCE, DCE (1,1; trans-1,2; and cis-1,2), 1,1-DCA, 1,2-DCA, PCE, benzene, toluene, ethylbenzene, and total xylenes.

Once all analytical data from the field laboratory are available, they will be reviewed to evaluate the distribution of contamination (if any). Locations will be selected to obtain samples for fixed-laboratory analysis. An estimated 26 samples at Transicoil and 90 samples at the Nike site will have been obtained for field analysis. Twenty percent of these totals (i.e., 4 at Transicoil, 2 at Hitchens, and 16 at the Nike site) will be submitted for fixed-laboratory analysis. Approximately 50 percent of the samples selected for fixed-laboratory analyses will be collected from the top 6 inches of the soil column. Samples testing both positive and negative for VOCs in the field may be submitted to the offsite laboratory.

Samples from the Transicoil property will be analyzed for full TCL and TAL/CN analyses, and Freon 113. Samples from the Hitchens property and Nike Park will be analyzed for TCL volatiles and Freon 113. If VOCs are detected in any sample from the Hitchens property or Nike Park, the sample will also be analyzed for the complete TCL and TAL/CN analyses.

- All soil samples will be collected using a geoprobe pushed by a truck-mounted hydraulic press.

Table 2-2

SUMMARY OF FIELD SAMPLING AND ANALYSES¹

Page 1 of 2

Sampling Area	Number of Locations	Samples	Parameters Analyzed or Tested		
			Field and Onsite Laboratory	RAS	DAS
Transcoil Property	8 soil borings	Approximately 5 soil samples collected per boring, totaling approximately 40 soil samples. Approximately 2 soil samples per boring submitted for field laboratory analysis, totaling approximately 16 soil samples. Approximately 20 percent of field laboratory samples will be resampled and submitted to Central Regional Laboratory (CRL), totaling approximately 4 samples to CRL.	Field inspection, approximately 2 samples per boring submitted for onsite laboratory analysis for selected volatile organic compounds (VOCs): TCE, dichloroethene (DCE), dichloroethane (1,1-DCA), PCE, benzene, toluene, ethylbenzene, and total xylenes	On approximately 4 samples TAL and cyanide (TAL/CN) TCL (semivolatiles and pesticides/PCBs)	On approximately 4 samples TCL VOCs plus Freon 113 ²
Hitchens Property	5 soil borings	Approximately 5 soil samples collected per boring, totaling approximately 25 soil samples. Approximately 2 soil samples per boring submitted for field laboratory analysis, totaling approximately 10 soil samples. Approximately 20 percent of field laboratory samples will be resampled and submitted to CRL, totaling approximately 2 samples to CRL.	Field inspection approximately 2 samples per boring submitted for onsite laboratory analysis for selected VOCs: TCE, DCE, 1,1-DCA, PCE, benzene, toluene, ethylbenzene, and total xylenes		On approximately 2 samples TCL VOCs plus Freon 113 ²
Nike Missile Battery Control Area	45 soil borings	Approximately 5 soil samples collected per boring totaling approximately 225 samples. Approximately 2 soil samples per boring submitted for field laboratory analysis, totaling approximately 90 samples. Approximately 20 percent of field laboratory samples will be resampled and submitted to CRL, totaling approximately 18 samples to CRL.	Field inspection approximately 2 samples per boring submitted for onsite laboratory analysis for selected VOCs: TCE, DCE, 1,1-DCA, PCE, benzene, toluene, ethylbenzene, and total xylenes		On approximately 18 samples TCL VOCs plus Freon 113 ²

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Table 2-2
SUMMARY OF FIELD SAMPLING AND ANALYSES¹

Page 2 of 2

Sampling Area	Number of Locations	Samples	Parameters Analyzed or Tested		
			Field and Onsite Laboratory	RAS	DAS
Groundwater Monitoring Wells	17	17	Field inspection pH Eh Conductivity Temperature Dissolved oxygen	TCL (semivolatiles and pesticides/PCBs) TAL/CN (total and dissolved)	Low-level VOCs plus Freon 113
Packer Sampling of Monitoring Wells	2	Approximately 4 samples per monitoring well, total 8 samples			
Residential Wells	71	71	Field inspection pH Conductivity Temperature Dissolved oxygen		Low-level VOCs plus Freon 113
Sediment	4	4	Field inspection pH Eh Conductivity Temperature Color (Munsell)	TAL/CN TCL (semivolatiles and pesticides/PCBs)	TOC Grain size Freon 113 TCL (volatiles)
Surface Water	4	4	Field inspection pH Conductivity Temperature Dissolved oxygen	TCL (semivolatiles and pesticides/PCBs) TAL/CN	Alkalinity Hardness Total suspended solids Low-level VOCs plus Freon 113

¹Excludes QC samples, including duplicates.

²If VOCs are detected in any sample from the Hitchens property or Nike Park, the sample will also be analyzed for complete TCL and TAL analyses.

- **Groundwater Sampling:** Groundwater samples will be collected from 17 monitoring and production wells located on the Transicoil, Nike, and adjacent properties. These samples will be analyzed at an offsite laboratory for full TCL (low-level volatiles) and TAL/CN analyses, and Freon 113 (see Table 2-2).
- **Surface Water and Sediment Sampling:** Four sediment and four surface water samples will be collected to be analyzed by an offsite laboratory for full TCL, TAL/CN, and Freon 113. Surface waters also will be analyzed for total suspended solids, alkalinity, and hardness. Sediments will also be analyzed for total organic carbon, grain size, and percent solids/moisture to support the environmental assessment. Details are shown in Table 2-2.

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Section 3

Project Organization

Project Organization

The project team organization for the RI effort is shown in Figure 3-1. The responsibilities of key members of the project team are discussed below.

Primary responsibility for project quality rests with the EPA remedial project manager (RPM) and the CH2M HILL site manager (SM). Most soil samples will be analyzed in an onsite laboratory. The laboratory that will perform offsite analyses has not been identified. All routine analytical services (RAS) will take place through a CLP laboratory or the CRL. Delivery of analytical services (DAS) will be procured through CRL personnel, the CRL, or CH2M HILL.

Site Manager

The SM will be responsible for project execution and for all technical, financial, administrative, and agency-related aspects of the project. The SM will also select properly trained and qualified personnel. The SM will be the primary contact between CH2M HILL and the RPM.

Program Manager

The program manager will ensure that work is performed in accordance with the ARCS III Management Plan.

Field Team Leader/Field QC Manager

The field team leader will also be the field QC manager who reviews and advises on all aspects of QA/QC related to sample collection and shipping. Responsibilities include:

- Conducting field audits during execution of the program
- Auditing sample custody to determine if procedures specified in the SAP are followed
- Issuing corrective action orders when necessary

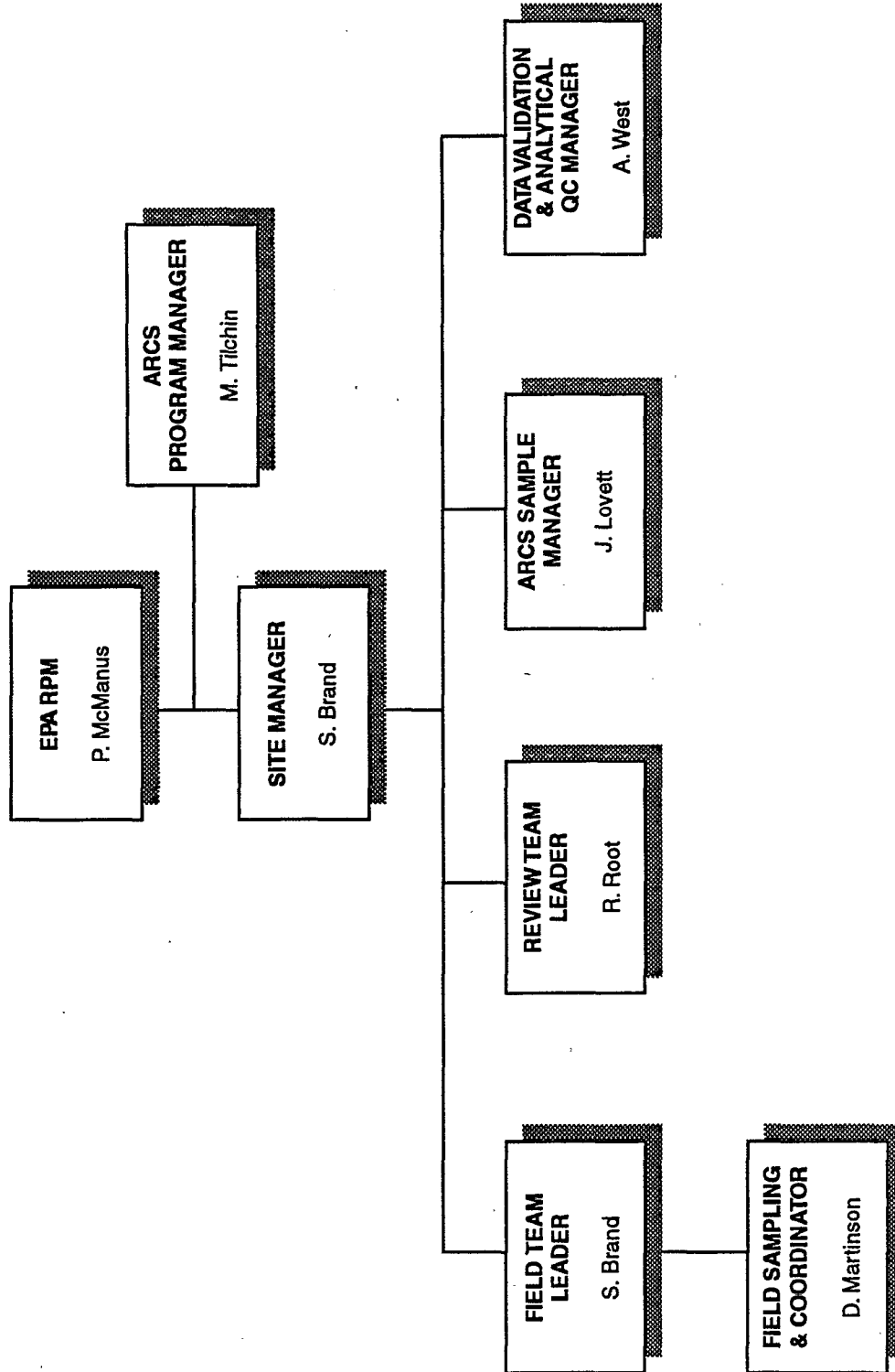


Figure 3-1
CH2M HILL PROJECT ORGANIZATION
North Penn Area RI/FS

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Table 3-1
QA ORGANIZATION

QA Task	Responsible Organization/Personnel
Overall management	EPA Region III/PO EPA Region III/RPM CH2M HILL/PM CH2M HILL/SM
Preparation of QAPP and supporting documents	CH2M HILL
Review and approval of QAPP and supporting documents	EPA Region III/RPM EPA Region III/CRL CH2M HILL/QC Manager CH2M HILL/SM
QA review and approval of reports. SOPs, field activities, auditing of reports, procedures, and internal corrective actions	CH2M HILL/Field Coordinator and CH2M HILL/SM
Evidence audits of field records	CH2M HILL/Field Coordinator QC
Approval of QA procedures for other than CLP-RAS	EPA Region III/CRL
Approval of QA plan for field sample collection and measurements	CH2M HILL/SM EPA Region III/RPM
Approval of field sample collection activities	CH2M HILL/QA Manager
CLP-RAS initiation of requests	CH2M HILL/ASM
DAS initiation and preparation of DAS requests	CH2M HILL/QC Manager
Review and approval of DAS	EPA Region III/CRL
Field laboratory analysis and documentation procedures	CH2M HILL/SM

Table 3-2
QA PROJECT PERSONNEL
NORTH PENN AREA 12

Site Manager and Field QC Manager	Stephen Brand CH2M HILL P.O. Box 4400 Reston, VA 22090 703/471-1441
Field and Sampling Coordinator	Don Martinson CH2M HILL P.O. Box 4400 Reston, VA 22090 703/471-1441
Analytical QC Officer, and Data Validation Manager	Ann West CH2M HILL P.O. Box 4400 Reston, VA 22090 703/471-1441
ARCS Sample Manager	Julie Lovett CH2M HILL P.O. Box 4400 Reston, VA 22090 703/471-1441

Analytical QC Officer

The Analytical QC Officer reviews and advises on all aspects of QA/QC related to samples analysis. Responsibilities include:

- Auditing to ensure that field analytical QA procedures are as specified in the QA/QC program
- Conducting laboratory audits when necessary during execution of the program
- Making QC evaluations and, if necessary, submitting audit samples to assist in reviewing QA/QC procedures; making recommendations to the SM concerning repeat samples and analysis if problems are detected

ARCS Sample Manager (ASM)

The primary responsibility of the ASM will be processing of the samples and the analytical data. The ASM will perform the following duties:

- Coordination with Region III for the delivery of sample containers and appropriate paperwork for sample collection, custody, and shipping
- Scheduling through Region III for analytical laboratory services by the contract laboratory program (CLP) or the Region's central regional lab (CRL)
- Processing of analytical results in parallel with validation and presentation of the results for the final report

Field Coordinator (FC)

The FC will coordinate and implement all CH2M HILL field activities associated with the sampling and ensure adherence to all QA/QC procedures outlined in the Sampling and Analysis Plan (SAP). The FC's responsibilities include:

- Verifying that field personnel are trained and qualified in sampling procedures and field analytical procedures, before taking samples
- Verifying that field analytical QC procedures were followed as specified in the SAP
- Participating in the field analytical/sampling quality audits with the Field and Analytical QC Officers

Field Personnel (Sample Collectors)

The field personnel will be under the direction of the FC. The field personnel will be responsible for the following:

- Collecting and labeling the samples following the procedures outlined in the FSP
- Taking photographs of the sampling locations
- Completing all necessary documentation
- Packing and shipping the samples
- Verifying that samples are collected, labeled, preserved, stored, transported, and when necessary, filtered as specified in the SAP
- Checking that all sample documentation (labels, field notebooks, chain-of-custody (COC) records, packing lists) is correct and transmitting that information with the samples to the analytical laboratory
- Preparing Oversight Reports

Data Validator (DV)

The DV when required, will systematically review the analytical data for compliance with the established QA/QC criteria based on the results provided by the laboratory. The DV will also determine data usability.

Data validation on samples collected by CH2M HILL and analyzed by CRL or a CLP laboratory will be done by CRL. CH2M HILL has also received analytical laboratory reports on a significant amount of sampling performed by the PRP during previous RI/FS activities. These data have not been validated to CLP standards. At the suggestion of EPA, CH2M HILL will revalidate all soil results that will be used in the risk assessment. CH2M HILL will not revalidate drinking water or groundwater samples because we will be resampling these locations.

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Section 4

Quality Assurance Objectives

To ensure that the data generated during RI can support the decision-making process for determining a site remedial plan, clear definitions of the RI/FS objectives and the procedures for collecting data are required. This goal is facilitated by data quality objectives (DQOs).

DQOs are established for each major sample collection effort as specified in the *Data Quality Objectives: Remedial Guidance for Uncontrolled Hazardous Waste Sites, For Remedial Response Activities* (U.S. EPA, 1987). DQOs are the quantitative and qualitative descriptions of the quality of data required to support an environmental decision or action. As target values for data quality, they are not necessarily criteria for acceptance or rejection of data. The data user develops DQOs for a specific purpose. Everyone from the data gatherer to the analytical laboratory is involved in the process from the beginning. The DQO development process involves three stages, including:

- Definition of the question or decision to be made
- Clarification and precise identification of the information required
- Data collection program design

The following paragraphs describe the DQOs for the sampling and analysis of each media at the North Penn Area 12 Site. In order to achieve the DQOs, a combination of laboratory services will be used for a more efficient use of time and money. One component of DQOs is the QA level for the analyses being performed. The QA levels generally are described as follows:

- **Screening** (Level I) provides the lowest data quality but the most rapid results. The generated data will provide presence-absence indications of certain constituents, and are generally qualitative, rather than quantitative. These analyses will include onsite measurements using the HNu for organic vapors in soils and pH, conductivity, and temperature in groundwater samples.
- **Field Analysis** (Level II) provides rapid results and better quality data than Level I. Level II data may be used in the alternatives evaluation when accompanied by appropriate QA/QC procedures.
- **Engineering** (Level III) provides an intermediate level of data quality and is used for site characterization. Engineering analyses may include mobile laboratory-generated data and contract laboratory program (CLP) analytical laboratory methods, usually without the validation or documentation required by CLP Level IV analysis. A mobile laboratory will be used to analyze soil

samples collected at North Penn Area 12. The soil sampling subcontractor will provide the mobile laboratory. This data will be used to characterize soil contamination on the site and identify potential source areas.

- **Confirmational** (Level IV) provides the highest level of data quality and is used for risk assessment, engineering design, and cost recovery documentation. Confirmation analyses require full CLP analytical and data validation procedures. The North Penn Area 12 site analytical program incorporates CLP analysis for every matrix.
- **Analysis by Non-Standard Methods** (Level V) applies to analyses performed in an offsite analytical laboratory that may or may not be a CLP laboratory. Method development or method modification may be required for specific constituents or detection limits. DAS are Level V. DAS will be performed on all water samples for low level volatiles and for freon on every matrix. Also total suspended solids, total organic carbon, alkalinity, grain size, and hardness will be performed by DAS.

The North Penn Area 12 RI/FS may generate Levels I, II, III, IV, and V analytical data. Level I data are typically not suitable to support the risk assessment and alternatives evaluation. Levels II and III analytical data may be used in the alternatives evaluation when accompanied with appropriate QA/QC procedures. Levels IV and V analytical data will ensure detection limits that will allow comparison with ARARs for water and support the risk assessment and alternatives evaluation.

The overall QA objective is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide legally defensible results in a court of law. This section addresses objectives for accuracy; precision; and sensitivity of laboratory analyses; level of QA effort; method detection limits; and completeness, representativeness, and comparability. Table 4-1 shows the quantitative goals for the QC parameters for the chemical analysis that will be performed on the samples for this project. These parameters will be determined by the quality control measures taken in the field and in the laboratory. Field activities will be assessed by blanks and duplicates. Laboratory activities will be subject to the Sample Management Office (SMO) compliance screening. The frequencies of QC measures are shown in Table 4-2 and are described in Section 10 of this QAPP.

Table 4-1
PRECISION, ACCURACY, AND COMPLETENESS QUANTITATIVE GOALS*

Parameters	Precision (Relative Percent Difference)	Accuracy % Spike Recovery	% Completeness
TCL - VOCs (RAS & DAS)	<±20	80-120	85
TCL - BNAs	<±20	80-120	85
TCL - Pesticide/PCBs	<±20	80-120	85
TAL - Metals	<±20	80-120	85
Cyanide (total)	<±20	80-120	85
Freon - 113	<±20	80-120	85
Hardness	<±30	NA	85
TSS	<±30	NA	85
TOC	<±30	NA	85
Alkalinity	<±30	NA	85

*These DQOs are adequate as guidelines to provide data of acceptable quality for the investigation. If the analytical method lists criteria that have limits that are expanded relative to these, then the method criteria for those compounds will take precedence. Surrogate recoveries, MS/MSD recoveries and RPDs accuracy criteria will consist of those established by the method.

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Table 4-2
COLLECTION FREQUENCIES OF FIELD QC SAMPLES

Analysis	Field Handling Blank	Trip Blank	Field Duplicate	Additional Volume Needed of Any One Sample for MS/MSD/MD*
TCL - VOCs (RAS & DAS)	1/20 samples per matrix or 1 per event	1/day per matrix	1/20 samples per matrix	Triple volume per 20 samples for aqueous, double volume for solids**
TCL - BNAs (RAS)	1/20 samples per matrix or 1 per event	Not applicable	1/20 samples per matrix	Triple volume per 20 samples for aqueous, double volume for solids
TCL - Pest/PCBs (RAS)	1/20 samples per matrix or 1 per event	Not applicable	1/20 samples per matrix	Triple volume per 20 samples for aqueous, double volume for solids
TAL - Metals (RAS)	1/20 samples per matrix or 1 per event	Not applicable	1/20 samples per matrix	Double volume per 20 samples*
Cyanide (total) (RAS)	1/20 samples per matrix or 1 per event	Not applicable	1/20 samples per matrix	Double volume per 20 samples*
Freon 113 (DAS)	1/20 samples per matrix or 1 per event	Not applicable	1/20 samples per matrix	Double volume per 20 samples
Hardness (DAS)	1/20 samples per matrix or 1 per event	Not applicable	1/20 samples per matrix	Not applicable
Alkalinity (DAS)	1/20 samples per matrix or 1 per event	Not applicable	1/20 samples per matrix	Not applicable
TSS (DAS)	1/20 samples per matrix or 1 per event	Not applicable	1/20 samples per matrix	Not applicable
TOC (DAS)	1/20 samples per matrix or 1 per event	Not applicable	1/20 samples per matrix	Not applicable

*MD = matrix duplicate analysis will be performed instead of MSD for metals and cyanide.

**Single volume will be collected for low concentration VOCs since SAMLCWOA does not require MS/MSD, but requires analysis of LCS.

Precision

Precision is the measure of the agreement or repeatability of a set of replicate results obtained from repeat determinations made under the same conditions. The precision of a duplicate determination can be expressed as the relative percent difference (RPD), as determined by the following equation:

$$RPD = \frac{|X_1 - X_2| \times 200}{X_1 + X_2}$$

where: X_1 = first duplicate value
 X_2 = second duplicate value

For a given laboratory analysis, the replicate RPD values are tabulated, and the mean and standard deviation of the RPD are calculated. Control limits for precision are usually plus or minus two standard deviations from the mean.

Accuracy

Accuracy is a measure of the agreement between an experimental determination and the true value of the parameter being measured. Analytical accuracy can be determined using known reference materials or matrix spikes. Spiking of reference materials into the actual sample matrix is the preferred technique because it quantifies the effects of the matrix on the analytical accuracy. Accuracy can be expressed as the percent recovery (P) determined by the following equation:

$$P = \frac{SSR - SR}{SA} \times 100$$

where: SSR = spiked sample result
SR = sample results (native)
SA = spike added

For this investigation, the accuracy statement that can be generated for the analytical laboratory is through the use of the matrix spike.

Accuracy and precision will be monitored by using field duplicate, matrix spike, matrix duplicate, and/or matrix spike duplicate samples. Blanks and duplicates will be handled in the same way as the samples they accompany. A surrogate spike is a spiked sample similar to a matrix spike. However, surrogates are compounds which are similar to the

analytes of interest in chemical composition, but which are not normally found in environmental samples.

Known quantities of surrogates are added to all blanks, standards and samples prior to sample extraction and recoveries are monitored to assess the extraction process and matrix interference. Variations from 100 percent recovery for surrogates and matrix spikes may be due to matrix interferences, laboratory handling procedures or heterogeneities between sample aliquots. Although these data alone cannot evaluate accuracy and precision of individual samples, they will assess the long-term accuracy and precision of the analytical method for the sampling event.

Representativeness

Representativeness is a measure of the degree to which sample data accurately and precisely represent parameter variations at a sampling point. For the North Penn Area 12 site activities, representativeness is a measure of how closely the measured results reflect the actual distribution and concentration of certain chemical compounds in each of the matrices sampled. Representativeness should be considered as an objective to be achieved, rather than a characteristic which can be described in quantitative terms. It can be evaluated based on two different criteria. The analytical results must adequately characterize the sample and the process or condition that was being investigated. Proper analytical technique employed with a comprehensive QA/QC program will ensure the first criteria, and suitable sampling ensure the second criteria. The FSP describes the procedures to collect the samples. This process will generate samples that are as representative as possible. Documentation of field procedures, as described in the FSP, will establish that protocols have been followed and that sample identification and integrity have been maintained.

Completeness

Completeness is defined as the percentage of analytical measurements made that are judged to be valid with validity being defined by the DQOs. Percent completeness is calculated as the number of valid analyses divided by the total number of analyses performed, multiplied by 100. The completeness objective has been set at 85 percent for the project. Where DQOs are not defined, the completeness check will include accountability of results for all samples shown on chain-of-custody forms.

Comparability

Comparability is the term that describes the confidence with which one data set can be compared to another. Comparability refers to such issues as using standardized sampling and analytical techniques and using consistent reporting units. This criterion becomes important if more than one field team is collecting samples or more than one laboratory is analyzing the samples. It is also important to be able to compare data from various sampling rounds.

Detection Limits

The detection limits required to be met for the TAL inorganic analytes, cyanide, and TCL organic compounds using analytical methods are the Contract Required Detection Limits under the CLP program. Detection limits for analytes to be analyzed under DAS will be outlined in the DAS requests.

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Section 5 Sample Collection Procedures

A detailed description of sampling procedures is provided in the attached FSP. Procedures are included that describe, at a minimum:

- Sample plan design considerations
- Sampling point selection
- Sample packing, handling, and shipment (including time considerations)
- Special conditions for sample container preparation and time requirements (tabulated)
- Preparation and use of trip blanks and field blanks
- Documentation of sampling activities (field forms, logbooks, photologs to record sample history, sampling conditions, and sample analyses to be conducted)
- Decontamination of personnel and equipment
- Disposal of investigation-derived wastes

Sample containers, preservatives, and holding times are shown in Tables 5-1, 5-2, and 5-3.

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**Table 5-1
SAMPLE CONTAINERS, PRESERVATIVES, HOLDING TIMES
FOR LIQUID SAMPLES**

Analysis	Container Type	Number of Containers Required for		Preservatives and Storage Requirements	Maximum Holding Times
		Regular Samples	Samples Including Lab QC ^a		
TOC	250 ml P/G	1	2	H ₂ SO ₄ to pH <2	28 days
TCL Volatiles (RAS & DAS) plus Freon 113	40-ml glass VOA vial ^b	3	9	HCl in 2 of each 3 containers ^{c,d} 4°C	7 days w/o HCl, 14 days w/HCl
TCL Semivolatiles (BNA) and TCL Pest/PCBs	4-liter amber glass bottle ^c -or- 2-liter amber glass bottle ^c	1 -or- 2	2 -or- 4	4°C ^d	7 days to extraction; 40 days after extraction
TAL Metals	1-liter plastic bottle	1	2	HNO ₃ to pH <2	180 days (6 mo); Hg, 28 days
TAL Cyanides	1-liter plastic bottle	1	3	NaOH to pH >12 ^d	14 days
Alkalinity	1-liter plastic bottle	1	2	4°C	14 days
TSS	250 ml P/G	1	3	Cool to 4°C	7 days
Hardness	250 ml P/G	1	2	HNO ₃ to pH <2	28 days

Notes: VOA = volatile organic analyzer

P/G = polyethylene or glass

4-liter or 1-gal

2-liter or 80-oz

1-liter or 1-quart

500-ml or 1-pint

^aLab QC samples will be taken once for every 20 samples of the same matrix. These include MS/MSD (organics) and spike/duplicate (inorganic) samples. Lab QC samples will be identified on sample labels and chain of custody forms.

^bTeflon-lined cap or septum.

^cPreserve 2 of each 3 of the VOC containers and clearly mark the preserved vials.

^dIf residual chlorine is present (treated drinking water or treatment plant effluent) the following dechlorinators must be added prior to preservation:

BNA/Pest/PCB - 10% sodium thiosulfate solution

VOC, CN - ascorbic acid

Table 5-2
SAMPLE CONTAINERS, PRESERVATIVES, HOLDING TIMES
FOR SOLID SAMPLES

		Number of Containers Required for			
Analysis	Container Type	Regular Samples	Samples Including Lab QC ^a	Preservatives and Storage Requirements	Maximum Holding Times
TOC Organics	3 oz. wide- mouth glass jar	1	2	4°C	28 days
TCL Volatiles (RAS & DAS) plus Freon 113	40 ml glass VOA vial ^b	2	6	4°C	7 days
TCL Semivolatiles (BNA) and TCL Pest/PCBs	6 oz. glass jar ^b	1	2	4°C	7 days to extraction; 40 days after extraction
TAL Metals	6 oz. jar	1	2	4°C	180 days (6 mo); Hg, 28 days
TAL Cyanides	6 oz. jar	1	2	4°C	14 days
Grain Size	8 oz. jar	1	1	Unpreserved	Not Applicable
Notes: ^a Lab QC samples will be taken once for every 20 samples of the same matrix. These include MS/MSD (organics) and spike/duplicate (inorganic) samples. Lab QC samples will be identified on sample labels and chain-of-custody forms. ^b Teflon lined cap or septum.					

Table 5-3 PRESERVATIVES	
Preservatives	Concentration
HCl	1:1
HNO ₃	25%
H ₂ SO ₄	Concentrated
NaOH	10N
All preservatives will be minimum reagent grade chemicals.	

Section 6

Sample Custody

Essential to any sampling and analytical program is maintaining the integrity of the sample from collection to data reporting. This requires tracing the possession and handling of samples from the time of collection, through analysis, to final disposal. This documentation is referred to as chain-of-custody (COC). The project-specific procedures for sample custody are described fully in Section 3.0 of the FSP. The essential components of this COC are described in detail in the FSP and summarized below.

Field Custody

The SM is responsible for the care and custody of samples until they are shipped or otherwise delivered to the laboratory custodian.

Transfer of Custody

The COC form is to be completed before samples are shipped. The persons involved in relinquishing and receiving the samples will sign, date, and note the time of sample receipt on the COC form. The first such transfer may occur between the field sampler and the sample carrier. Another transfer may occur between the sample carrier and the laboratory sample custodian. Each sample shipment will be accompanied by a COC record that identifies the contents of the shipment.

Laboratory Custody

The laboratory custodian will verify that the custody seals on the sample shipment or the containers are intact and that the information on the COC matches the actual contents. The laboratory custodian will also note any anomalies, such as broken bottles, elevated temperatures, and missing labels. The CLP laboratories have an EPA-approved system to track a sample from its receipt through analysis to its final disposition. The laboratory will retain sample identification tags, data sheets, original instrument output records, and logbooks, as part of the final evidence file. The project-specific procedures for sample custody are described fully in Section 3.6 of the FSP.

Sample Disposal

Unless otherwise instructed, the analytical laboratory will dispose of unused sample portions, according to Resource Conservation and Recovery Act (RCRA) regulations, after the analyses have been completed and any outstanding issues between the contractor and the laboratory have been resolved.

Data Submittal by the Laboratory

Requirements for data submitted for DAS request analyses are specified in the analysis request to the laboratory. A full data package will be submitted by the lab for TCL, TAL/CN analysis as required by CLP.

Final Evidence File

The laboratory is required to retain and deliver to EPA all materials pertaining to the sample and its analysis in the format and time frame specified in the CLP-SOW. Any additional requirements not covered in the CLP-SOW are identified in the DAS request shown in Appendix A. North Penn Areas 12 sampling documentation will be archived at the CH2M HILL Reston office. This documentation will also be transferred to microfiche for permanent storage. Upon project close-out, all North Penn Area 12 documents will be relinquished to EPA.

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Section 7 Equipment Calibration

Various instruments will be used in the field and in the laboratory to collect data and monitor site conditions. Proper calibration, maintenance, and use of these instruments is important for collecting quality data. A record of calibration and maintenance activities is as important as the data record itself.

Field Equipment Calibration

The following field equipment to be used during the field activities requires calibration:

- pH meter
- Conductivity meter
- HNu

The pH meter, conductivity meter, and HNu will be calibrated before and during each day's use according to procedures and schedules outlined in the HSP and in the FSP. The standards which will be used to calibrate these instruments are shown in Table 7-1. Standards will be purchased as necessary from appropriate vendors. Information about each standard including the dates, manufacturer, lot number, and description will be entered into the field notebook. This information will be used to trace standards.

The calibration results will be recorded in the field log books and summarized in the calibration sheets found in the SOPs in Appendix A of the attached FSP.

If an individual suspects an equipment malfunction, the device shall be removed from service, tagged so that it is not inadvertently used, and the ARCS equipment manager notified so that a substitute piece of equipment can be used. Backup equipment will be available in the field for use in the event of a malfunction.

Equipment that fails calibration or becomes inoperable during use, shall be removed from service and tagged so that it is not inadvertently used. Such equipment shall be repaired and satisfactorily recalibrated. Equipment that cannot be repaired will be replaced.

Results of activities performed using equipment that has failed recalibration shall be evaluated. If the results are adversely affected, the outcome of the evaluation will be documented and the SM notified.

Table 7-1 CALIBRATION STANDARDS				
Instrument	Calibration Standard	Span	Reading	Method
HNu, 10.2 ev probe	100 ppm isobutylene	9.8 ± 2.0	55 ppm	1.5 l/m reg: T-tubing
HNu, 11.7 ev probe	100 ppm isobutylene	5.0 ± 2.0	68 ppm	1.5 l/m reg: T-tubing
pH meter	pH 4 and 7 Buffers	N/A	N/A	N/A
Conductivity meter	EC 225 and 1,000 $\mu\text{s/cm}$	N/A	N/A	N/A

Laboratory Calibration

The CLP or non-CLP laboratory itself is responsible for equipment and instrument calibration and maintenance. Manufacturer's guidance should be followed for general upkeep. The laboratory is also required to comply with calibration criteria specified in the CLP User's Guide and instructions provided with requests for non-CLP analyses.

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Section 8

Analytical Procedures

Samples collected during the investigation will be analyzed by the CRL, a CLP laboratory, or a designated laboratory.

Laboratory analysis for the field investigation will be done for TAL metals, cyanide, and TCL organics with a RAS request. Laboratory analysis for low concentration volatiles, freon, total suspended solids, alkalinity, hardness, and total organic carbon will be done through DAS analyses. The DAS requests are included in Appendix B. The RAS and DAS methodologies and QC samples are shown in Table 8-1.

Routine Analytical Services

The ASM will arrange RAS laboratory scheduling. The ASM will notify personnel at the Regional Sample Control Center (RSCC) at CRL who will in turn notify the SMO of the planned sampling schedules in sufficient time to allow for assignment and scheduling of the laboratories. The sample shipments, as they occur, will be reported by the RSCC to SMO within 24 hours of the shipment.

Delivery of Analytical Services

Analysis of low-concentration volatiles, freon, hardness, grain size, alkalinity, total suspended solids, and total organic carbon does not fit the CLP-RAS requirements and will be performed under the DAS program. Laboratory assignments and scheduling are handled differently for DAS requests than for RAS requests. A detailed DAS request form, including analytical procedures, QC requirements, and data deliverable requirements must be prepared and sent (by diskette) to the RPM for approval. The RPM is responsible for reviewing and approving DAS requests. The RPM sends the DAS form to the regional point of contact (RPOC).

DAS requests require a lead time of about 6 to 8 weeks. The CRL has first chance of being awarded the contract. If CRL cannot do the analyses then the RSCC uses a blanket purchase agreement to obtain bids from laboratories.

CH2M HILL will be notified by the RPOC if the analysis will cost more than \$25,000. CH2M HILL then is responsible for procuring a laboratory. Delays in submitting a completed DAS to the RPM or the RSCC may delay sampling.

Table 8-1
SUMMARY OF QC SAMPLES AND OFFSITE ANALYSES
NORTH PENN AREA 12 RI/FS

Matrix	Analyses and Analytical Methods	Samples	Field Duplicates	Total Field, Equipment, and Trip Blanks	MS MSD Samples	Total Samples
Residential Drinking Water	TCL: Low Level Volatiles plus Freon 113 (SAML COWA)	71	4	15	4	94
Groundwater	TCL: Low Level Volatiles plus Freon 13 (SAML COWA)	25	2	15	2	44
	TCL: Semivolatile organic compounds (OLM01)	25	2	4	2	33
	TCL: Pesticides and PCBs (OLM01)	25	2	4	2	33
	TAL: Metals total (ILM01)	25	2	4	2	33
	TAL: Metals dissolved (ILM01)	25	2	4	2	33
Surface Water	TCL: Low Level Volatiles plus Freon 13 (SAML COWA)	4	1	4	1	10
	TCL: Semivolatile organic compounds (OLM01)	4	1	2	1	8
	TAL: Metals total (ILM01)	4	1	2	1	8
	TAL: Metals dissolved (ILM01)	4	1	2	1	8
	TSS: (EPA 160.2)	4	1	2	1	8
	Hardness (EPA 130)	4	1	2	1	8
	Alkalinity (EPA 310.1)	4	1	2	1	8
	TCL: Volatiles plus Freon 113 (OLM01)	4	1	4	1	10
	TCL: Semivolatile organic compounds (OLM01)	4	1	2	1	8
Sediment	TCL: Pesticides and PCBs (OLM01)	4	1	2	1	8
	TAL: Metals total (ILM01)	4	1	2	1	8
	TOC (EPA 415.1)	4	1	2	1	8
	Grain Size (ASTMD422)	4	1	0	0	5
	TCL: Volatiles plus Freon 113 (OLM01)	4	1	4	1	10
Soil	TCL: Volatiles plus Freon 113 (OLM01)	24	2	19	2	47
	TCL: Semivolatile organic compounds (OLM01)	24	2	4	1	31
	TCL: Pesticides and PCBs (OLM01)	4	1	2	1	8
	TAL: Metals (ILM01)	4	1	2	1	8

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Sample Preparation

Methods for preparing samples of various matrices for RAS analyses are found in the appropriate CLP SOWs. Methods for preparing samples for DAS analyses are found in the site-specific DAS request forms, or in the analytical procedure referenced in the DAS.

Instrument Performance Criteria

Minimum performance specifications for analytical instruments used in RAS or DAS analyses are found in the appropriate CLP SOWs for RASs or are described in the DAS request form for DAS. A laboratory must meet these criteria before initiating the analysis of samples.

Detection Limits

Minimum method detection limits that a CLP laboratory must achieve for RAS analyses are found in the appropriate CLP SOWs. For DAS analyses, the minimum method detection limits are specified in the site-specific DAS requests.

Initial and Continuing Calibration Criteria

The requirements for initial calibration and daily or continuing calibration are specified in the appropriate CLP SOWs for RAS analyses and in the site-specific DAS requests for DAS analyses.

Laboratory QC Criteria

Criteria for determining the accuracy and precision of the analytical methods and laboratory preparation procedures involve blanks, surrogates, matrix spikes, and duplicate analyses. The exact procedures and frequencies for these QC methods are specified in the appropriate CLP SOWs for RAS analyses and in the site-specific DAS requests for DAS analyses.

Data Transmittal

The time, format, and content requirements for the submittal of deliverables are specified in the appropriate CLP SOWs for RAS analyses and in the site-specific DAS requests for DAS analyses.

Section 9

Data Reduction and Reporting

Data reduction and reporting are steps in the overall management and use of both field and laboratory data. Figure 9-1 shows the flow of information and sample tracking forms.

Data Reduction

Definition

Analytical data collected will be input into a computerized data base. Data will be entered once and will be verified by spot-checking procedures. The sample manager will handle data entries that are unverified. Units for water sample results will be reported in $\mu\text{g/l}$ and soils in $\mu\text{g/kg}$.

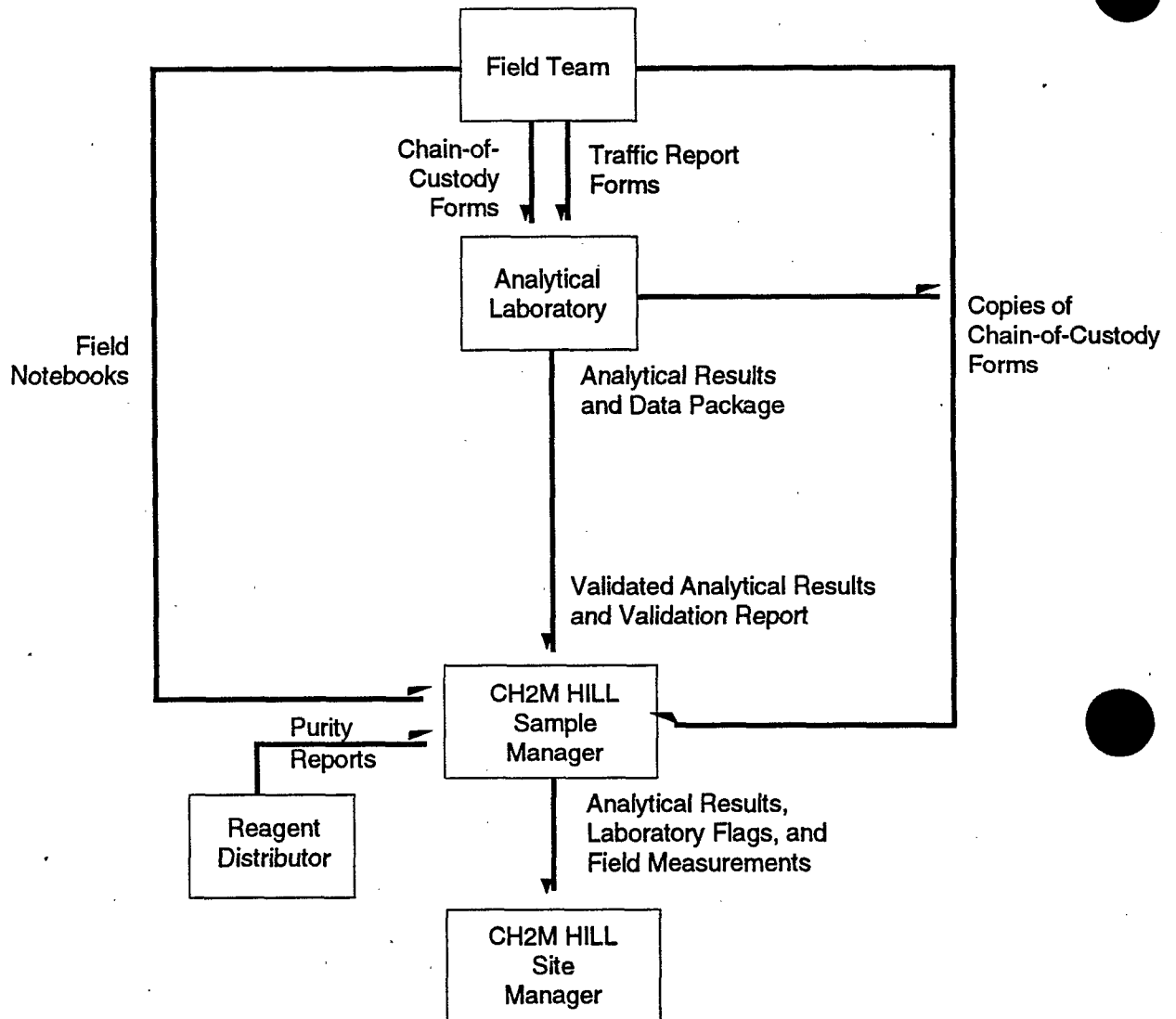
Background Data

Background data produced for internal records and not reported as part of the analytical data include the following: laboratory worksheets, laboratory notebooks, sample tracking system forms, instrument logs, standards records, maintenance records, calibration records, and associated quality control. These sources will be available for inspection during audits and to determine the validity of data.

Data Validation

Data validation (level M3 and 1M2) on samples collected by CH2M HILL and analyzed by CRL or a CLP laboratory will be done by CRL. Validation of conventional chemistry parameters is not planned.

CH2M HILL has also received analytical laboratory reports on a significant amount of sampling performed by the PRP during the previous RI/FS activities. These data have not been validated to CLP standards. At the suggestion of EPA, CH2M HILL will revalidate all soil results that will be used for risk evaluation. CH2M HILL will not revalidate drinking water and groundwater samples because we will be resampling these locations. The data validation to be conducted by CH2M HILL will be done in accordance with *Region III Modification to National Functional Guidance for Data Review*, dated June 1992 for VOCs and BNAs and May 1993 for Pesticides and Inorganics and the most current version of the EPA document *Laboratory Data Validation, Functional Guidelines for Evaluating Organics and Inorganics Analysis* (drafted June 1991).



- Hardcopy Files
- Chain-of-Custody
 - Traffic Reports
 - Field Notebooks
 - Analytical Data Packages

Figure 9-1
FLOW OF FORMS AND SAMPLE
AND ANALYSIS INFORMATION
North Penn Area 12 RI/FS

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There are currently no data validation guidelines for the DAS parameters. Therefore, when validating DAS analytical data, data validators will refer to the following:

- The DAS request instruction
- The analytical method referenced in the DAS request
- The data validator's professional judgment and experience

The data validation personnel are familiar with the North Penn Area 12 project, its objectives, and the intended use of the data. A data validation report using the format specified by the Region will be prepared.

Records

The following describes procedures for maintaining the project's records:

- SMs shall maintain records in accordance with the requirements of this section until those records are turned over to the EPA for storage. All records shall be accessible to the EPA until they are turned over to the EPA.
- The SM shall determine the records to be generated before the start of work. These records will be listed in the site-specific FSP.
- Records of field activities that support the integrity of samples shall be entered on bound and numbered pages. Such records shall be dated and signed or otherwise authenticated on the day of entry.
- Records retained on file shall be indexed. The indexing system shall include the location of records within the indexing system. (The indexing system shall be in alphabetical, chronological or numerical order, or as otherwise indicated in written procedures.)
- There shall be sufficient information in records to permit identification between the record and the item(s) or activity to which it applies. Identification of records will be by means that permit traceability.
- The records storage system shall provide for accurate retrieval of records without undue delay.

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Section 10

Internal Quality Control Checks

A number of QA/QC samples will be collected to check the overall adequacy of sample collections and analysis, and to monitor laboratory performance. Duplicates, blanks, and spiked samples are used to test the sampling and analysis techniques to determine if the techniques affect the analytical results. They also measure the internal consistency of the samples and estimate any variance or bias in the analytical process. The field and laboratory QA/QC sampling requirements are described below. A summary of QC samples taken is included in Table 8-1.

Field Sampling Quality Control Procedures

Quality control duplicate samples and blanks provide a measure of the samples' internal consistency and estimate variance and bias.

Blanks provide a measure of cross-contamination, decontamination efficiency, and other potential errors that can be introduced from sources other than the sample. The following paragraphs describe the QA/QC samples.

- Field replicates are collected at a frequency of 1 per 20 samples.
- Equipment blanks are collected at a frequency of 1 per 20 samples.
- Field blanks are collected at a frequency of 1 per 20.
- Matrix spike/matrix spike duplicates (MS/MSD) are collected for TCLs at a frequency of 1 per 20. MS/MSDs represent samples for which extra volume must be collected for the laboratory to perform contract required QC analyses. Triple the normal volumes will be collected for any one volatile sample and double the normal volumes for semivolatiles, pesticides, and PCBs. Matrix spike/matrix duplicates are collected at a frequency of 1 per 20 for inorganics (including TALs and cyanide).

Trip Blank

A daily TCL VOC trip blank will be prepared for each matrix collected for VOC analysis (see Section 5 of the FSP). This includes subsurface soils, groundwater, surface water, and sediment. The trip blanks for the samples will consist of Baker Instra-analyzed HPLC grade water sealed in two 40 ml VOA vials along with a preservative (hydrochloric acid).

One trip blank will be included with each daily shipment of VOC samples. The trip blank will be prepared before each sampling event, shipped or transported to the field with the sampling bottles, and then shipped unopened with the samples to the laboratory. Trip blanks will indicate if there is any VOC contamination during shipment to the field, from storage in the field, or from shipment from the field to the analytical laboratory.

Equipment Blank

The equipment blanks checks for cross contamination during the collection, handling, preservation, and shipment of a sample. The equipment blank for soil, groundwater, surface water, and sediment samples will consist of HPLC grade water which is poured over a piece of equipment which has been used to collect a sample and then field decontaminated. The water is then collected in a sample bottle, preservatives are added as appropriate, and the sample bottle is capped, packed, and shipped with the other samples. Baker Instru-analyzed Inc., HPLC grade water will be used for these equipment blank samples.

Field Duplicates

One field duplicate sample will be obtained for every 20 field samples collected for each matrix (soil, groundwater, surface water, etc.). The sampling location where the duplicate is taken from will be randomly selected for each event. Each duplicate sample will be split evenly into two sample containers and submitted for analysis as two independent samples.

Field Blank

One field blank sample will be submitted for each 20 field samples collected. The field blank serves as a measure of the purity of the water used for collection of blanks, and of contaminants resident in air in the sample container storage area. Water is transferred to a sample bottle, preservatives added as appropriate, and the sample bottle is capped, packed, and shipped with the other samples. Baker Instru-analyzed Inc., HPLC grade water will be used for the field blank samples.

Laboratory Analytical Quality Control Procedures

The analytical laboratory will use all of the quality control elements of the EPA CLP, including matrix spikes (MS), matrix spike duplicates (MSD), duplicates, and laboratory blanks. The analytical laboratory will be CLP or CRL. The laboratory qualifications are maintained by SMO for EPA.

Matrix Spike/Matrix Spike Duplicate/Matrix Duplicate

MS/MSD or MD samples will be spiked in two separate aliquots of a sample selected from a batch of 20 field samples. The MS will assess accuracy, and the MSD or MD will assess the accuracy, precision, and reproducibility of the analytical results.

Laboratory Blanks

Method blanks will be analyzed for background contamination from the laboratory as specified by the appropriate CLP SOWs and DAS request forms.

Laboratory Duplicates

Laboratory duplicates will be analyzed to assess precision of the laboratory analysis as specified by the appropriate CLP SOWs and DAS request instructions.

Laboratory Control Sample (LCS)

An LCS containing all compounds of concern at a concentration near the method detection limit is added to lab water for volatiles analysis by SAMLCWOA. Recovery of LCS helps assess the spiking efficiency of volatile compounds at low levels.

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Section 11

Performance and Systems Audits

Audits of field sampling and testing activities will be conducted at least once during activities that may affect the integrity of the sample program. The audits will cover, in general, verification that approved procedures are in place and used, an acceptable calibration program is in place, an organization structure is in place, personal responsibilities are clearly defined, a training program for personnel is in place and current, a COC program and records retention program are in place, and corrective action of variances taken by laboratory and field personnel is responsive and timely. EPA Regional Technical Project Officer and SMO is responsible for conducting CLP lab audits.

Laboratory Performance and Systems Audits

The analytical laboratory will conduct both internal and external quality control checks. External quality control checks include participation in EPA's certification programs in which laboratories analyze QC samples of known concentrations received from EPA. Internal quality control checks (replicates, spikes, and duplicates) are performed in accordance with CLP methods as specified in the DAS request.

Field Team Performance and Systems Audits

A performance audit will be conducted by the Field QC Officer during the first day of sampling to verify that proper procedures are followed and that subsequent sampling data will be valid. The audit will focus on the details of the QA program. The audit checklist, which will serve as the guide for the performance audit for field procedures, is shown in Figure 11-1. The audit will determine whether or not:

- Collection of samples follows the available written procedures
- COC procedures are followed for traceability of sample origin
- Operational procedures to verify that the appropriate QC checks are being made in the field and records of these checks are being implemented
- Sampling crews are adequately trained
- Recordkeeping procedures are being followed; field notebooks, logsheets, bench sheets, and tracking forms are properly prepared and maintained
- Corrective action procedures are followed

An audit report summarizing any results and corrections will be given to the SM and filed in the project files. Significant variances from established procedures will be reported to the RPM.

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Figure 11-1
FIELD PERFORMANCE AUDIT CHECKLIST

Project Responsibilities

Project No.: _____

Date: _____

Project Location: _____

Signature: _____

Team Members: _____

Yes ___ No ___

1) Was a SAP Prepared?

Comments _____

Yes ___ No ___

2) Was a briefing held for project participants?

Comments _____

Yes ___ No ___

3) Were additional instructions given to project participants?

Comments _____

Sample Collection

Yes ___ No ___

1) Is there a written list of sampling locations and descriptions?

Comments _____

Yes ___ No ___

2) Are samples collected as stated in the FSP?

Comments _____

Yes ___ No ___

3) Are samples collected in the type of containers specified in the FSP?

Comments _____

Figure 11-1
FIELD PERFORMANCE AUDIT CHECKLIST
(Continued)

Yes ___ No ___ 4) Are samples preserved as specified in the FSP?
Comments _____

Yes ___ No ___ 5) Are the number, frequency, and type of samples collected as specified in the FSP?
Comments _____

Yes ___ No ___ 6) Are quality assurance checks performed as specified in the FSP?
Comments _____

Yes ___ No ___ 7) Are photographs taken and documented as specified in the FSP?
Comments _____

Document Control

Yes ___ No ___ 1) Have any accountable documents been lost?
Comments _____

Yes ___ No ___ 2) Have any accountable documents been voided?
Comments _____

Yes ___ No ___ 3) Have any accountable documents been disposed of?
Comments _____

Figure 11-1
FIELD PERFORMANCE AUDIT CHECKLIST
(Continued)

- Yes ___ No ___ 4) Are the samples identified with sample tags?
Comments _____

- Yes ___ No ___ 5) Are blank and duplicate samples properly identified?
Comments _____

- Yes ___ No ___ 6) Are samples listed on a chain-of-custody record?
Comments _____

- Yes ___ No ___ 7) Is chain-of-custody documented and maintained?
Comments _____

WDCR821/030.WP5

WDCR821/030.WP5

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Section 12

Preventative Maintenance

Routine maintenance procedures and schedules for sampling equipment are described in the manufacturer's instruction manuals. All records of inspection and maintenance will be dated and documented in the field notebook.

Maintenance procedures and schedules for all field and laboratory analytical instruments will strictly follow the recommendations of the equipment manufacturers. Routine laboratory equipment maintenance will be performed by laboratory personnel as needed. All records of inspection and maintenance will be dated and documented in laboratory record books.

Critical spare parts for the HNu and the pH and conductivity meters include batteries, electrodes, and membranes. They will be included in the sampling kits to minimize downtime. In addition, back-up meters will be available in the field office trailer, if needed. Spare parts will be purchased from accepted vendors.

WDCR821/031.WP5

Section 13

Data Assessment Procedures

The precision and accuracy of data will be routinely assessed to ensure that they meet the requirements of the DQOs.

Precision is commonly determined from duplicate samples; thus precision is usually expressed as RPD or relative standard deviation (RSD). These quantities are defined as follows.

$$RPD = \frac{|X_1 - X_2|}{(X_1 + X_2)} \times 200$$

$$RSD = (100/2) \times [2|X_1 - X_2|/(X_1 + X_2)]$$

where X_1 and X_2 are the reported concentrations for each duplicate sample

Accuracy is commonly presented as percent bias or percent recovery. Percent bias is a standardized average error; that is, the average error divided by the actual or spiked concentration and converted to a percentage. Percent bias is unitless, so it allows the accuracy of analytical procedures to be compared easily.

Percent recovery provides the same information as percent bias. Accuracy is often determined from spiked samples. Percent recovery is defined as:

$$\% \text{ Recovery} = \frac{SSR - SR}{SA} \times 100$$

where

SSR	=	spike sample results
SR	=	sample result
SA	=	spike added

Given this definition it can be shown that

$$\% \text{ bias} = \% \text{ recovery} - 100$$

A database will be created for the North Penn Area 12 project. Validated data will be entered into this database whereupon a myriad of statistical procedures can be performed.

WDCR821/032.WP5

Section 14 Corrective Actions

The SM is responsible for initiating corrective actions. Corrective action steps will include problem identification, investigation responsibility assignment, investigation, action to eliminate the problem, increased monitoring of the effectiveness of the corrective action, and verification that the problem has been eliminated. The SM will also take necessary action on the results of audits performed.

Documentation of the problem is important to the overall management of the study. A Corrective Action Request Form for problems associated with sample collection, shown in Table 14-1, will be completed by the person discovering the QA problem. This form identifies the problem, establishes possible causes, and designates the person responsible for action. The responsible person will be the SM.

The Corrective Action Request Form includes a description of the corrective action planned and has space for follow-up. The SM will verify that initial action has been taken and appears to be effective and, at an appropriate later date, check to see if the problem has been fully resolved. The SM receives a copy of all Corrective Action Request Forms and enters them into the Corrective Action Log. This permanent record will aid the SM in follow-up and will assist in resolving quality assurance problems. All corrective action documentation will be archived at CH2M HILL's Reston office.

Examples of corrective actions include, but are not limited to, correcting COC forms, analysis reruns (if holding time criteria permit), recalibration with fresh standards, replacement of sources of blank contamination, examination of calculation procedures, additional training in sample preparation and analysis, reassignment of analytical responsibilities using a different batch of containers, or recommending an audit of laboratory procedures. Additional approaches may include:

- Resampling and analyzing
- Evaluating and amending sampling and analytical procedures
- Accepting the data and acknowledging the level of uncertainty or inaccuracy by flagging the data and providing an explanation for the qualification

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Table 14-1
CORRECTIVE ACTION REQUEST FORM
(Sample Collection)

Originator: _____ Date _____

Person responsible for replying: _____

Description of problem and when identified: _____

State cause of problem, if known or suspected: _____

Sequence of Corrective Action (CA): (If no responsible person is identified, submit this form directly to the RTL.)

State date, person, and action planned:

CA initially approved by: _____ Date: _____

Follow-up date: _____

Final CA approval by: _____ Date: _____

Information copies to:

RESPONSIBLE PERSON: _____

RTL: _____

SM: _____

Section 15 Quality Assurance Reports

A QA report may be completed at the end of the field activities to summarize the QA/QC status of the project and any problems. The report may assess the measured QA parameters; e.g., precision, accuracy, results of performance audits, any reported non-conformance, and any significant QA problems and the recommended solutions. Any change in the QAPP will be summarized in a report or letter and sent to the RPM and distributed to the CH2M HILL project team.

For this project no separate report is anticipated to describe the QA/QC achieved. The final project report will contain separate QA sections that summarize QA/QC information generated during the course of the project.

A summary of the analytical results will be included in the RI report. Complete data packages will be returned to EPA during project closeout activities. A copy of the complete data packages will be maintained in microfiche format with the project files.

WDCR821/034.WP5

**NORTH PENN AREA 12
SITE RI/FS**

**FIELD SAMPLING PLAN
(FSP)**

EPA CONTRACT NO. 68-W8-0090
EPA WORK ASSIGNMENT NO.: 90-36-3LW5.0
CH2M HILL PROJECT NO.: MAE63149.PP.QS

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION III
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CH2M HILL
RESTON, VIRGINIA

JULY 1994

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Section 1 Introduction

This field sampling plan (FSP) describes the scope of field activities CH2M HILL will perform during the RI/FS at the North Penn Area 12 site. The FSP was prepared in accordance with "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA, 1988). The field investigation scope of work is also outlined in the North Penn Area 12 Site RI/FS Work Plan.

The scope of field activities at the North Penn Area 12 site includes collecting samples of soil, surface water, and groundwater from monitoring and residential wells.

The objectives of this FSP are to specify the following:

- The location and frequency of samples to be collected
- The field procedures and criteria used to collect representative samples and measurements
- The analytical parameters and procedures for each matrix sampled
- The sample preservation, custody, packaging, and shipment procedures
- The procedures to be used to obtain adequate quality control and proper documentation

Project Objectives

The overall objective of this project is to conduct an RI/FS consistent with, and meeting the requirements of, the statutes, regulations, and EPA guidance noted in this section. The specific objectives of the RI/FS at the North Penn Area 12 site have been tailored to account for site-specific characteristics and the unique nature of the site. The objectives are listed below.

- Define the nature and extent of soil contamination at the site.
- Define the source, nature, and extent of groundwater contamination and the actual and potential pathways for contaminant migration at the site.
- Identify existing and potential environmental and human exposure points to contaminants at the site.

- Perform an assessment of the risks to human health and to the environment.
- Identify and evaluate remedial alternatives for the site.

The specific objectives of each of the proposed tasks are discussed by task in Section 2.

Other more specific project objectives are the following:

- Identify former and existing sources of VOC groundwater contamination on the Transicoil property.
- Develop a conceptual model of the site hydrogeology and evaluate the migration pathways of site-related VOCs.
- Define the extent of site-related groundwater contamination.
- Identify downgradient users of groundwater and determine if they are using water affected by releases from the site.
- Provide interim remedial measures where contamination of residential drinking water wells exists above acceptable levels.
- Identify existing and potential long-term risks to human health and the environment that are related to the site.
- Develop and evaluate ranges of remedial action alternatives to:
 - Provide water that does not exceed MCLs to affected residences; if no MCLs are available, risk-based concentrations will be calculated
 - Restore the contaminated aquifer to within acceptable contaminant levels
 - Remediate source areas to minimize their impacts to human health and the environment
- Identify former and existing sources of groundwater contamination by site-related chemicals on the property formerly occupied by the Nike battery control facility.
- Investigate possible releases from the site to surface water and stream sediments.

WDCR826/003.WP5

Section 2

Sampling Plan

2.1 Introduction

This section of the FSP describes the locations, frequency, analytical methods, equipment, and procedures associated with the sampling activities. Procedures are generally found as Standard Operating Procedures (SOPs) which are presented in Appendix A and referenced in this section as they pertain.

The sampling activities are discussed below by activity and are summarized in Table 2-1.

2.2 Soil Sampling

Objectives

The objectives of the soil sampling are:

- To additionally characterize the contaminant concentrations in the soil in the Transicoil drainfield
- To determine types and concentrations of possible contaminants in the soil at the former Nike missile battery control area
- To determine types and concentrations of possible contaminants in the soils in the mounded material and waste disposal areas of the Hitchens property
- To provide data for the surface soil and subsurface soil exposure assessment

Locations and Approach

The soil samples planned at the site are shown in Table 2-1. The soil samples are broken out by sampling area. The proposed soil boring locations are shown on Figures 2-1 and 2-2.

There will be eight soil borings drilled on the Transicoil property. Seven of these borings will be placed in the center and east areas of the drain field. One will be placed at the west corner of the property where debris and other materials have historically been stored.

Table 2-1 SUMMARY OF FIELD SAMPLING AND ANALYSES ¹					Page 1 of 2
Sampling Area	Number of Locations	Samples	Parameters Analyzed or Tested		
			Field and Onsite Laboratory	RAS	DAS
Transcoil Property	8 soil borings	Approximately 5 soil samples collected per boring, totaling approximately 40 soil samples. Approximately 2 soil samples per boring submitted for field laboratory analysis, totaling approximately 16 soil samples. Approximately 20 percent of field laboratory samples will be resampled and submitted to CRL, totaling approximately 4 samples to CRL.	Field inspection, approximately 2 samples per boring submitted for onsite laboratory analysis for selected VOCs: TCE, DCE, 1,1-DCA, PCE, benzene, toluene, ethylbenzene, and total xylenes	On approximately 4 samples TAL/CN TCL (semi volatiles and pesticides/PCBs)	On approximately 4 samples TCL VOCs plus Freon 113 ²
Hitchens Property	5 soil borings	Approximately 5 soil samples collected per boring, totaling approximately 25 soil samples. Approximately 2 soil samples per boring submitted for field laboratory analysis, totaling approximately 10 soil samples. Approximately 20 percent of field laboratory samples will be resampled and submitted to CRL, totaling approximately 2 samples to CRL.	Field inspection approximately 2 samples per boring submitted for onsite laboratory analysis for selected VOCs: TCE, DCE, 1,1-DCA, PCE, benzene, toluene, ethylbenzene, and total xylenes		On approximately 2 samples TCL VOCs plus Freon 113 ²
Nike Missile Battery Control Area	45 soil borings	Approximately 5 soil samples collected per boring totaling approximately 225 samples. Approximately 2 soil samples per boring submitted for field laboratory analysis, totaling approximately 90 samples. Approximately 20 percent of field laboratory samples will be resampled and submitted to CRL, totaling approximately 18 samples to CRL.	Field inspection approximately 2 samples per boring submitted for onsite laboratory analysis for selected VOCs: TCE, DCE, 1,1-DCA, PCE, benzene, toluene, ethylbenzene, and total xylenes		On approximately 18 samples TCL VOCs plus Freon 113 ²

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Table 2-1
SUMMARY OF FIELD SAMPLING AND ANALYSES¹

Page 2 of 2

Sampling Area	Number of Locations	Samples	Parameters Analyzed or Tested		
			Field and Onsite Laboratory	RAS	DAS
Groundwater Monitoring Wells	17	17	Field Inspection pH Eh Conductivity Temperature Dissolved Oxygen	TCL (semivolatiles and pesticides/PCBs) TAL/CN (total and dissolved)	Low level VOCs plus Freon 113
Packer Sampling of Monitoring Wells	2	Approximately 4 samples per monitoring well, totaling 8 samples			
Residential Wells	71	71	Field Inspection pH Conductivity Temperature Dissolved Oxygen		Low level VOCs plus Freon 113
Sediment	4	4	Field Inspection pH Eh Conductivity Temperature Color (Munsell)	TAL/CN TCL (semivolatiles and pesticides/PCBs)	TOC Grain size Freon 113 TCL (volatiles)
Surface Water	4	4	Field Inspection pH Conductivity Temperature Dissolved Oxygen	TCL (semi volatiles and pesticides/PCBs) TAL/CN	Alkalinity Hardness TSS Low level VOCs plus Freon 113

¹Excludes QC samples, including duplicates.

²If VOCs are detected in any sample from the Hitchens property or Nike Park, the sample will also be analyzed for complete TCL and TAL analyses.

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Five soil borings will be drilled on the Hitchens property in the mounded material and waste disposal areas as shown by aerial photographs. These samples along with the S-17 boring in the septic field will be used to assess the possible effects of material storage on the site.

In addition, approximately 45 soil borings will be drilled in the former Nike Missile Battery Control Area. The soil borings will be located in three areas not previously investigated. Soil sampling grids will be set up at each of the three areas, referred to as Areas A, B, and C. Soil borings will be completed on approximately 50- to 100-foot centers. The sampling grids may be modified by site conditions, evidence of contamination and location of existing structures. The borings will be advanced to refusal and 12-inch samples will be obtained for every 2 feet of soil in each boring.

All samples will be collected using a probe pushed by a truck-mounted hydraulic press. Each of the borings will be advanced to hydraulic probe refusal, estimated to be 10 feet. Twelve-inch samples will be collected for every 2 feet of soil, for a total of 5 samples per boring.

Selected samples, an estimated two per boring, will be analyzed for selected VOCs in an onsite laboratory. The soil samples will be screened with an OVM. Those two samples which produce the largest OVM readings in each borehole will be selected for analysis in the onsite laboratory. If all OVM readings are nondetect, the first sample will be collected from within the first 3 feet in the borehole, and the second sample will be collected from roughly the middle of the boring. Samples will be chosen preferentially for analysis if abnormal staining, odor, or some other information suggests a sample may be contaminated. The selected VOCs are TCE, DCE (1,1; trans-1,2; and cis-1,2), 1,1-DCA, 1,2-DCA, PCE, benzene, toluene, ethylbenzene, and total xylenes.

Once all analytical data from the field laboratory are available, they will be reviewed to evaluate the distribution of contamination (if any). Locations will be selected to obtain samples for fixed-laboratory analysis. An estimated 16 samples at Transicoil, 10 samples at Hitchens, and 90 samples at the Nike site will have been obtained for field analysis. Twenty percent of these totals (i.e., 4 at Transicoil, 2 at Hitchens, and 18 at the Nike site) will be submitted for fixed-laboratory analysis. Approximately 50 percent of the samples selected for fixed-laboratory analyses will be collected from the top 6 inches of the soil column. Samples testing both positive and negative for VOCs in the field may be submitted to the laboratory.

The soil samples will be analyzed by a Contract Laboratory Program (CLP) laboratory. Samples from the Transicoil property will be analyzed for full TCL and TAL analyses, and Freon 113. Samples from the Hitchens property and Nike Park will be analyzed for TCL volatiles and Freon 113. If VOCs are detected in any sample from the Hitchens property or Nike Park, the sample will also be analyzed for the complete TCL and TAL.

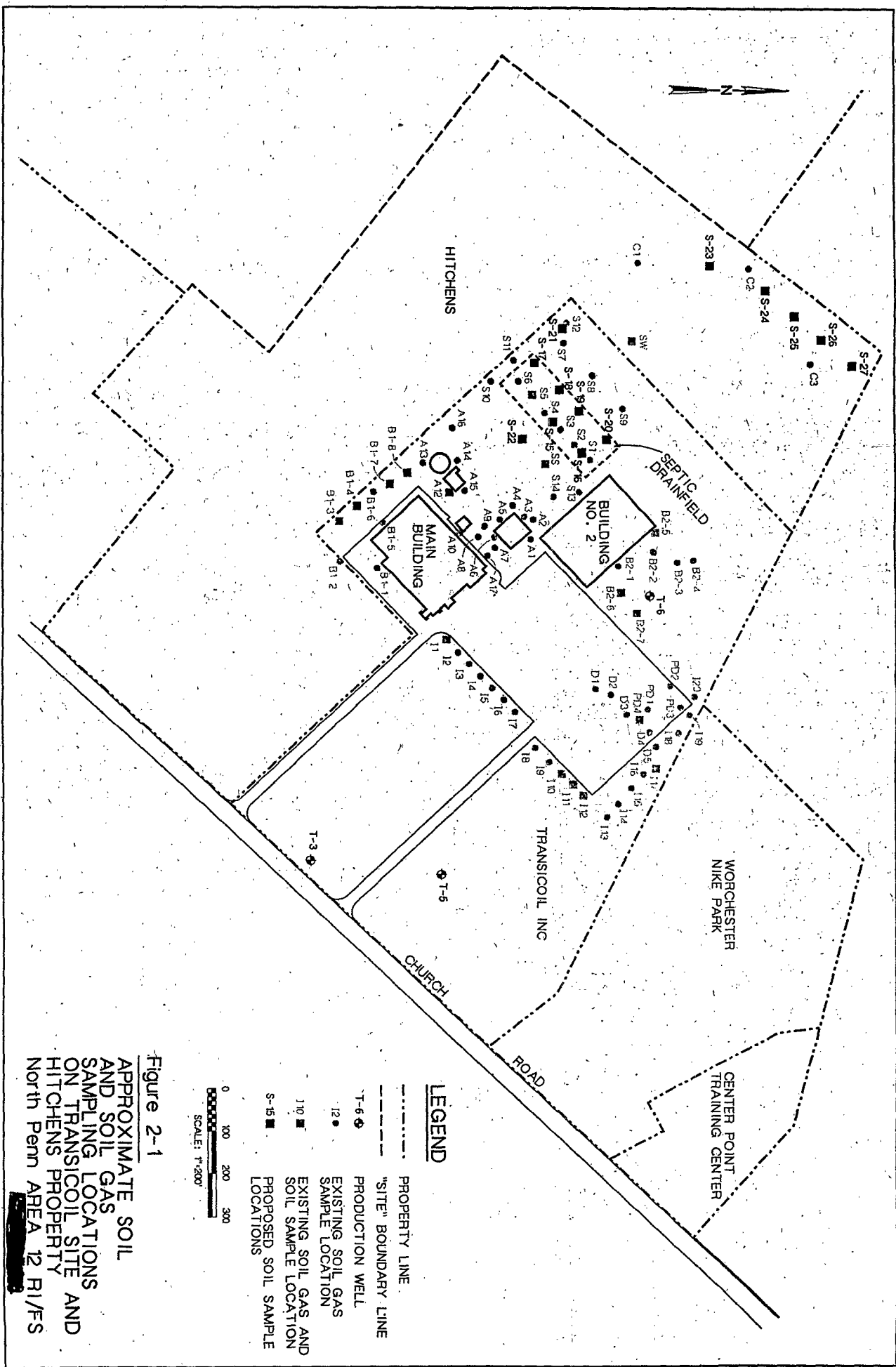


Figure 2-1
 APPROXIMATE SOIL
 AND SOIL GAS
 SAMPLING LOCATIONS
 ON TRANSICOLL SITE AND
 HITCHENS PROPERTY
 North Penn AREA 12 RI/FS

- LEGEND**
- PROPERTY LINE
 - "SITE" BOUNDARY LINE
 - T-6 ● PRODUCTION WELL
 - 12 ● EXISTING SOIL GAS SAMPLE LOCATION
 - 10 ● EXISTING SOIL GAS AND SOIL SAMPLE LOCATION
 - S-15 ■ PROPOSED SOIL SAMPLE LOCATIONS
- 0 100 200 300
 SCALE: 1"=200'

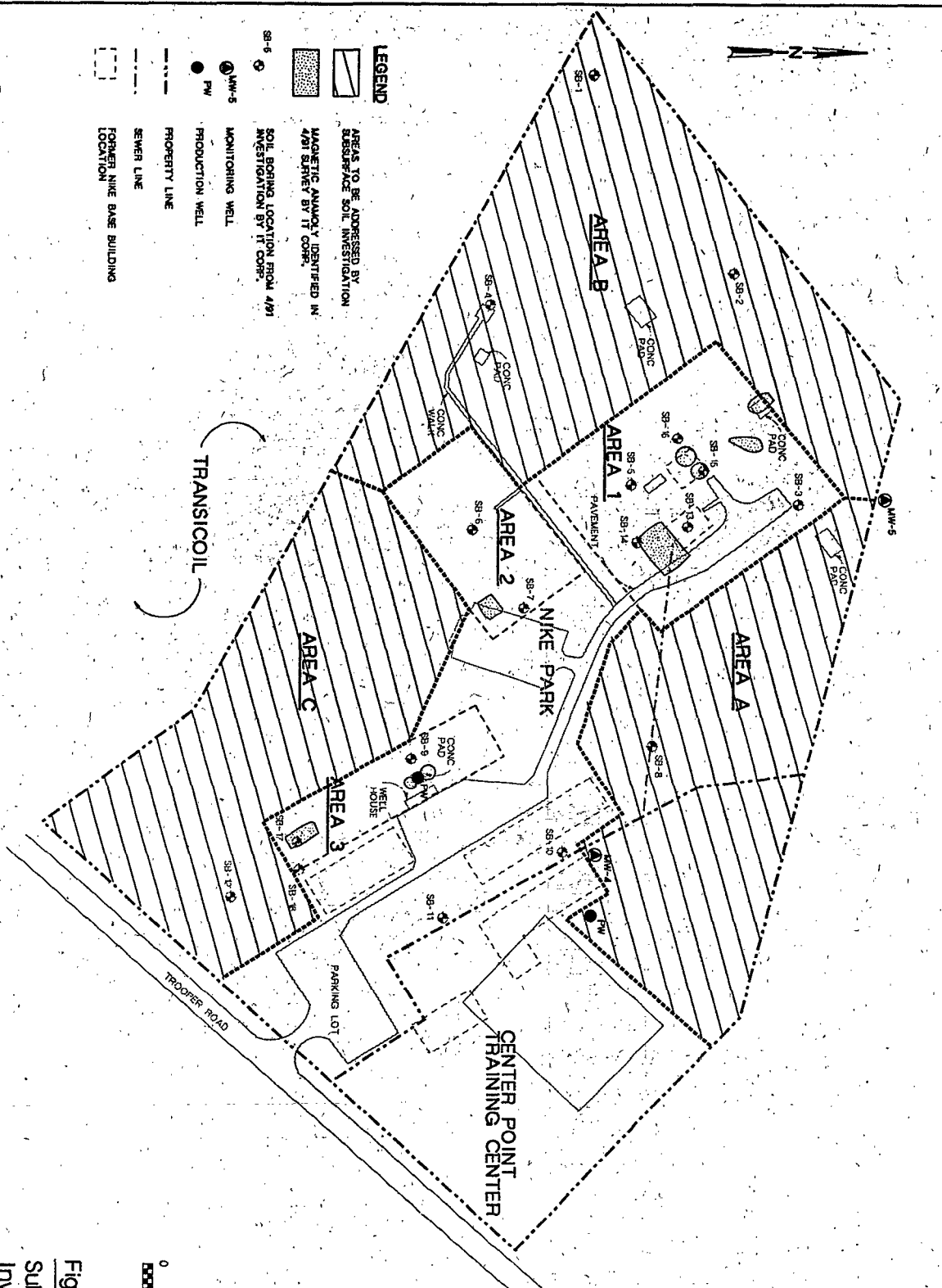


Figure 2-2
 Subsurface Soils
 Investigation Areas And
 Magnetic Anomalies On
 Former Nike Missile Site
 North Penn ~~Area 12, RI/FS~~

Method

Soil samples from both the Transicoil and Nike Park property will be obtained by a hydraulically-operated probing device. The hydraulic press is mounted on a truck or in a van. The press pushes the probe down to the desired depth and obtains the sample in a small thin-walled Shelby tube. Once the sample has been extracted from the tube it will be described and tested with a photo ionization detector (PID).

The soil sampling will occur according to the procedures outlined in SOP 2 and 3.

2.3 Groundwater Sampling

Objectives

The objectives of the groundwater sampling are to:

- Identify types and concentrations of contaminants in the onsite groundwater
- Evaluate the nature, extent, and movement of the contaminant plume

Location

The groundwater sampling subtask includes collection of groundwater samples from 17 monitoring and production wells located on the Transicoil, Nike, and adjacent properties (refer to Figure 2-3 and Table 2-2). The analytical results will be used to help define the extent of contamination in the vicinity of the site.

Methods

During the site visit, monitoring wells MW-1 through MW-6 will be checked for loss of depth. If significant depth loss is recorded, or if other information (e.g., evidence of iron, bacteria encrustation, and algal buildup) suggests that the well is in need of redevelopment, the well will be redeveloped before the sampling.

Before being sampled, the wells will be purged until the field parameters have stabilized or until the well pumps dry. Where possible, the wells will be purged using low-flow techniques and either a portable centrifugal pump and dedicated tubing, or a submersible pump decontaminated between wells. The samples will be collected from in line sampling ports on the pump where possible and dual valve dedicated bailers where the well pumps dry even under low-flow conditions. Wells will be pumped dry only if other purging methods fail. It is assumed that the four production wells to be sampled have operating pumps installed. For these wells, the samples will be collected using the in-place pump with the discharge throttled back as much as possible.

Table 2-2
NORTH PENN AREA 12 (TRANSICOIL)
MONITORING AND PRODUCTION WELL CONSTRUCTION DATA

Page 1 of 2

Well	Depth (ft, bgs) ^a	Ground Surface Elevation (feet) ^b	Top of Casing Elevation (feet)	Open Interval Length (feet)	Screened Interval Length (feet)
MW-1	122	471.95	474.18	102	NA ^c
MW-2	110	467.23	469.67	87	NA
MW-3	160	462.59	464.42	140	NA
MW-4	110	456.69	458.54	76	NA
MW-5	160	461.58	464.44	130	NA
MW-6 (on Transicoil Site)	92	d	d	NA	20
MW-7	95	d	d	NA	20
MW-8	72	d	d	NA	20
MW-9	124	d	d	NA	20
MW-10	154	d	d	NA	20
MW-11	106	d	d	NA	20
MW-12	211	d	d	94	d
Nike Park Production Well	e	456.79	457.85	--	NA
T-3	308	--	--	--	NA

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Table 2-2
NORTH PENN AREA 12 (TRANSICOIL)
MONITORING AND PRODUCTION WELL CONSTRUCTION DATA

Page 2 of 2

Well	Depth (ft, bgs) ^a	Ground Surface Elevation (feet) ^b	Top of Casing Elevation (feet)	Open Interval Length (feet)	Screened Interval Length (feet)
T-5	137	--	--	--	NA
T-6	913	--	--	--	NA
Rehab Center Prod. Well	--	--	--	--	NA

^aft, bgs = feet below ground surface
^bMSL Datum
^cNA - Not applicable
^dMW-6 through MW-12 will be surveyed as part of this study. MW-12 will be screened as part of this study.
^eData not available

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Monitoring wells MW-1 through MW-5 have insufficient data available to determine if low-flow sampling methods would be appropriate. Standard methods will be used, unless it is determined on the site that pumping to dryness can be avoided by the use of low-flow methods, and that the location of water-bearing zones can be interpreted from available data and well behavior.

Monitoring wells MW-6, MW-7, and MW-8 will be purged with standard techniques.

Monitoring wells MW-10, MW-11, and MW-12 will be purged with low-flow techniques. If parameters do not stabilize, or other problems are encountered, standard methods of well purging and sampling will be employed.

Monitoring well MW-9 will be purged with standard techniques. If it appears that it will pump dry, a low-flow technique will be used.

For all low-flow technique sampling, if the parameters do not stabilize, the standard purging and sampling techniques will be adopted.

Measurements of the field parameters, including pH, Eh, conductivity, dissolved oxygen (DO), turbidity, and temperature, will be taken in the field during sampling. These parameters will be compared to other available data to be sure the values obtained are representative of the groundwater at the site. Sampling will begin no sooner than approximately 2 weeks after well development is completed.

The groundwater sampling will be conducted according to SOP 7. Water level measurements will be collected according to SOP 12.

Monitoring wells MW-1 and MW-2 will be sampled in discrete intervals with packer sampling equipment. Packer sampling locations will be based on borehole geophysical information obtained from these wells. Composite sampling of MW-1, MW-2, and sampling of the remaining monitoring wells will be coordinated with packer sampling if possible to avoid the need to reinstall pumping equipment in monitoring wells MW-1 and MW-2.

All of the groundwater samples will be analyzed at a CLP laboratory for the full TCL semivolatiles and pesticides/PCBs, full TAL including cyanide, low level volatiles, and freon 113. TAL samples will be filtered in the field before preservatives are added. Unfiltered samples will also be collected for TAL analysis.

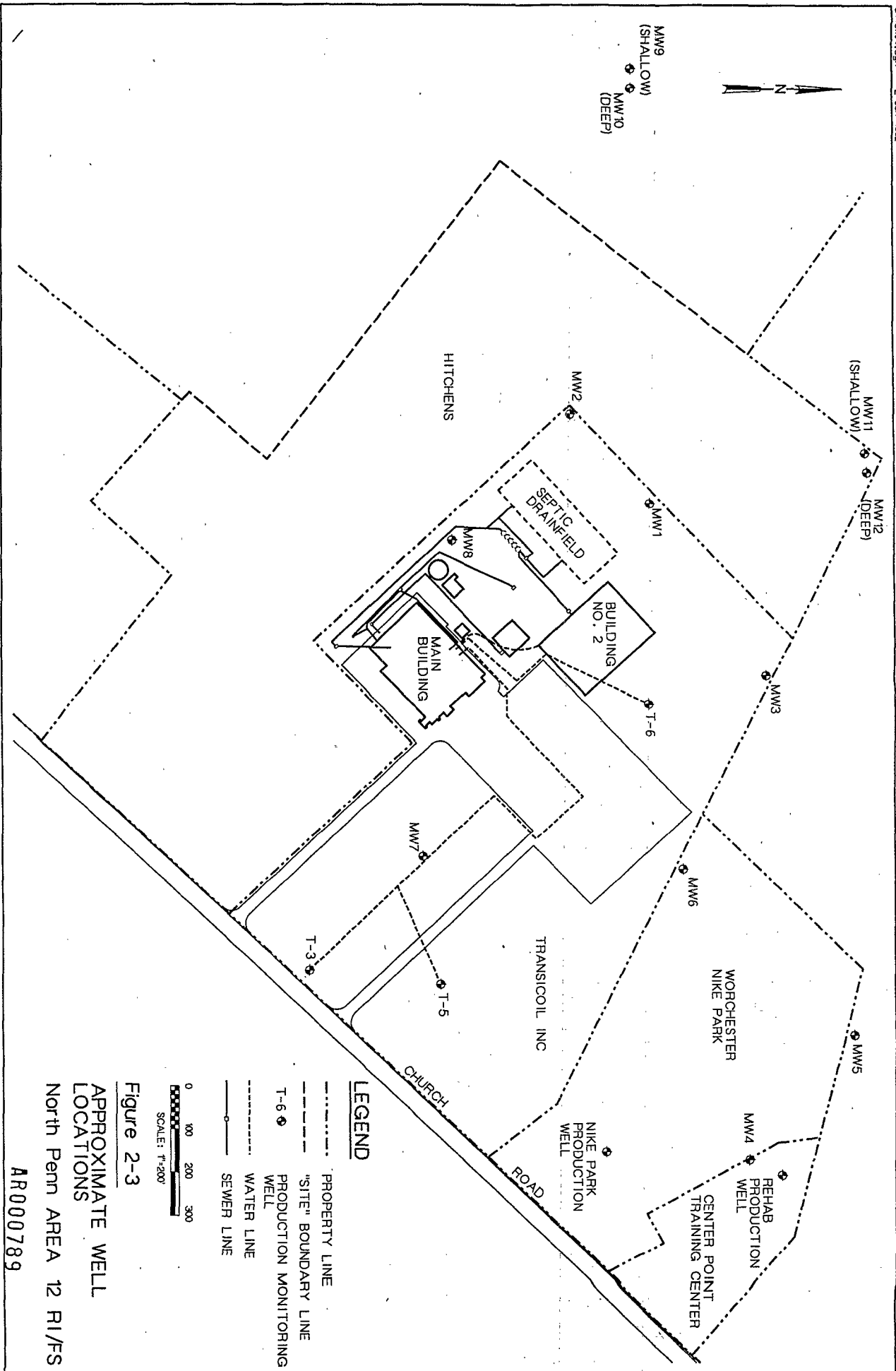


Figure 2-3
APPROXIMATE WELL
LOCATIONS
North Penn AREA 12 RI/FS

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2.4 Surface Water and Sediment Sampling

Objectives

Data on surface water and sediment contamination are not available for the site. Therefore, this task was included to characterize the surface water and sediment to support the environmental assessment that in turn will determine the site's impact on adjacent surface water, sediments, and wetlands.

Locations

An intermittent drainage is located to the southwest of the site. Part of this drainage has been identified as Wetlands D by ERM. The drainage flows into an unnamed creek to the southeast of the site. Four surface water and sediment samples will be collected from the drainage and creek shortly after a significant rainfall. Sample locations will be identified with EPA's input during the wetlands assessment, subtask FI.FB. Preliminary sample locations are shown in Figure 2-4. During the course of this investigation, additional surface water and sediment sampling locations may be identified.

Sample location 1 will be in the headwaters of the creek and will serve as a background sample in relation to the Transicoil property. Sample location 2 will be from one of the ponds within the creek and will provide data concerning contamination directly downgradient of the site. Location 3 will be in the wetlands area of the intermittent stream. Samples from this location will provide information concerning quality of surface water and sediments on the wetlands. Location 4 will be near or downstream of the confluence of the drainage and the creek to evaluate the level of contamination in the stream and sediments.

Methods

At each sample location, the surface water will be analyzed for pH, dissolved oxygen, specific conductance, and temperature. Because the streams to be sampled are intermittent, flow measurements will not be made. The sediment will be analyzed in the field for pH, Eh, specific conductance, temperature, and color (Munsell).

The sampling method to be used at the site is outlined in SOPs 5 and 6.

The four surface water and sediment samples will be sent to a CLP laboratory or to the CRL and will be analyzed for TCL volatiles (low level volatiles for waters), TCL semivolatiles, TCL pesticides and PCBs, TAL metals, and CFCs. Surface water samples also will be sent to a laboratory for total suspended solids, alkalinity, and hardness analyses. In addition, the sediment samples will be sent to a laboratory for total organic carbon analysis, grain size, percent moisture, and percent solids.

2.5 Residential Well Sampling

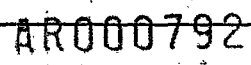
Objectives

The residential well sampling will be used to evaluate the current position and movement of the contaminant plume, the groundwater quality at residences not previously sampled but in the vicinity of residences with detectable concentrations of TCE, and the groundwater quality at residences sampled 2 years ago (during the first and second round of sampling) that have not received carbon units.

Locations

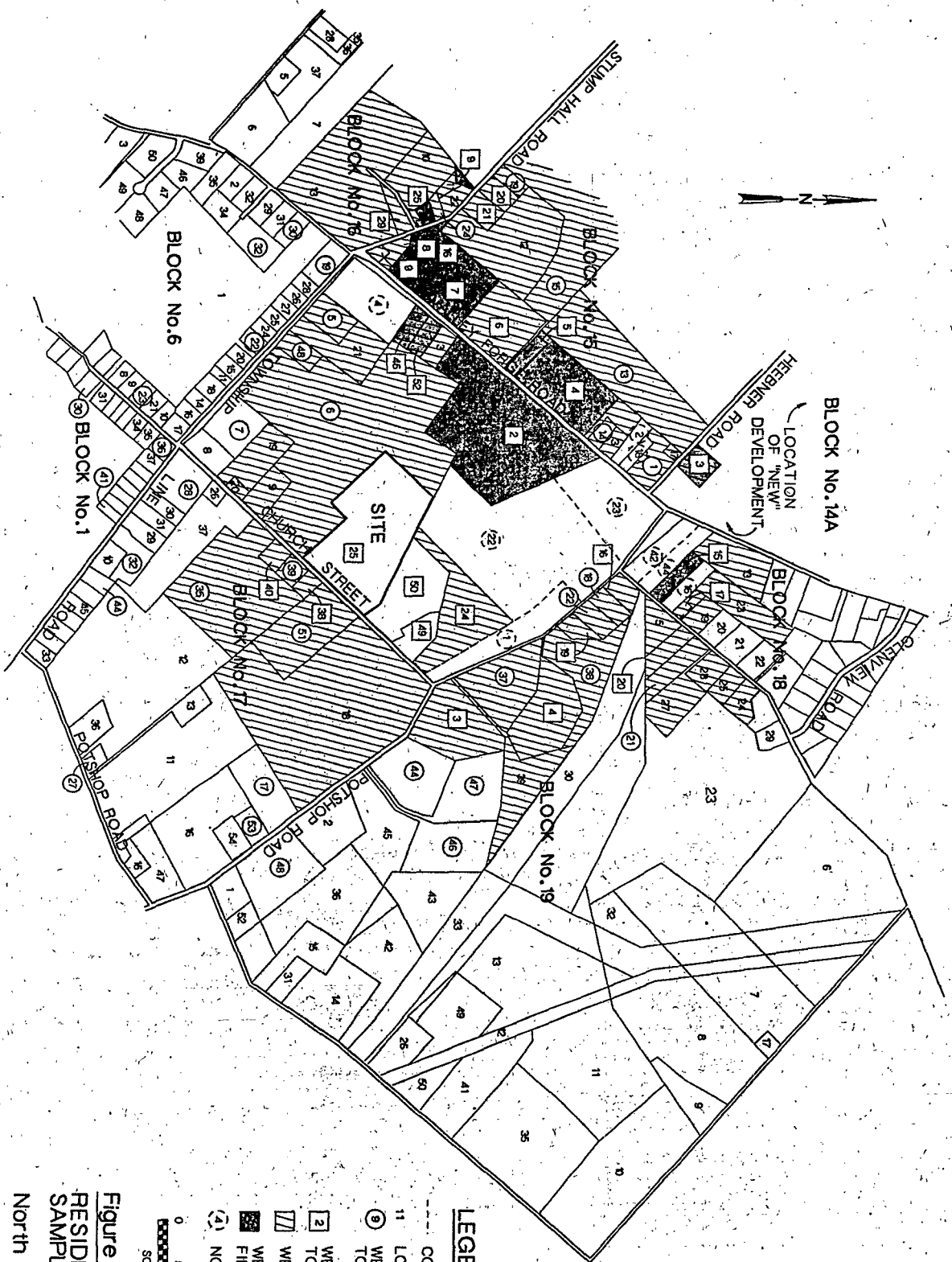
The residential well water samples will be analyzed for low level volatiles and freon. Currently there are no indications of other types of contaminants of concern present in the groundwater as a result of releases from the Transicoil site. CH2M HILL proposes to analyze samples from onsite wells for the complete suite of TCL and TAL/CN parameters. If additional contaminants of concern are identified, any future rounds of residential well sampling will be modified to address those compounds. The known locations proposed for the third sampling round are shown on Figure 2-5 and listed in Table 2-3. They include the following:

- Sample locations not previously sampled during residential sampling (23 known wells plus an estimated 10 yet-to-be identified residences and businesses from somewhere within blocks 16, 15, 14A, or 6). The northeast boundary of Block 6 will be well represented. Special emphasis will be placed on identifying and sampling the properties adjacent to properties previously sampled that had detected levels of contaminants in their well water. A trip will be completed to the local agency to review the area tax maps to identify private wells and home and business owners in the area.
- Residential wells sampled during the first round of sampling that have not received carbon units (23 wells).
- Residential wells sampled during the second round that have not received carbon filters (12 wells).
- Residential wells sampled during the first and/or second round that have received carbon filters (3 wells). These wells will be sampled before and after the carbon filters.



Proposed Wetlands
Delineation And Surface
Water And Sediment
Sampling Location Map
North Peninsula
April 22, 2012

North Penobscot Bay



LEGEND

- CONNECTED LOTS
- 11 LOT NUMBER
- ⑧ WELL PREVIOUSLY SAMPLED - TCE NOT DETECTED
- ② WELL PREVIOUSLY SAMPLED - TCE DETECTED
- ▨ WELL TO BE SAMPLED
- WELL PROVIDED WITH CARBON FILTER
- (4) NO WELL ON LOT

0 500 1000 1500
SCALE: 1"=1000'

Figure 2-5
RESIDENTIAL WELL
SAMPLING- THIRD ROUND
North Penn AREA 12 RI/FS

AR000793

Table 2-3
THIRD ROUND OF RESIDENTIAL WELL SAMPLING
SAMPLE LOCATIONS

Residential Wells Not Previously Sampled

Block No. 15	Lots 3, 12, 17
Block No. 16	Lots 10, 11, 12, 13, 22
Block No. 17	Lots 3, 9, 19, 20, 21, 18
Block No. 18	Lots 13, 19, 23
Block No. 19	Lots 5, 24, 25, 28, 39, 27

Selected Residential Wells Sampled During First Round (Not on Carbon)

Block No. 6	Lot 19
Block No. 15	Lots 8, 14, 20, 21
Block No. 16	Lot 24
Block No. 17	Lot 24 (2 wells), 38, 51, 39, 5, 6, 35, 48
Block No. 19	Lots 3, 16, 19, 18, 21, 22, 37, 38

Selected Residential Wells Sampled During Second Round (Not on Carbon)

Block No. 11	Lot 21
Block No. 15	Lots 6, 9, 1, 19, 15, 13
Block No. 16	Lot 29
Block No. 17	Lot 40
Block No. 18	Lot 17
Block No. 19	Lot 20, 4

Wells on Carbon (To be Sampled for Plume Monitoring Purposes)

Block No. 17	Lots 46, 52
Block No. 14A	Lot 3

Unidentified Sample Locations

Approximately 10 locations to be identified as part of this subtask

Methods

A four-step approach will be taken to perform the third round of residential well sampling. The initial step will include identifying the residences and businesses located to the north of the site in Block 14A, as previously discussed. The location of Block 11 will also be determined. This will be followed by the second step, which includes contacting by letter each of the residences and businesses selected to be sampled. The letter will explain the purpose of the sampling and will include a pre-addressed and stamped card asking if they are willing to participate. In addition, the letter will indicate the following: EPA is paying for the sampling and analysis; the resident will receive a copy of the analytical results; samples will be collected from outside taps, if possible, prior to any water treatment system; the well will be pumped for a minimum of 15 minutes prior to sampling; and the only cost for the homeowner or business is the electricity necessary to run the pump during sampling. Residents whose well(s) have not been sampled previously will be asked to fill out a well survey form to provide information about their well(s).

The third step will include placing phone calls to the residences who indicated a willingness to participate in the sampling and to the residences who did not respond to the letter. During this phone call, a time and date for the sampling will be selected and agreed to by the home or business owner. A follow-up card with the date and time of sampling will be mailed to the participants.

The fourth step, sampling, will take place over a 3-week period. A two- to three-person field team will sample approximately four wells per person per day.

Prior to sampling, each well will be monitored using an HNU organic vapor analyzer. In addition, conductivity, pH, dissolved oxygen, and temperature will be measured. Please see Appendix A for operating procedures.

2.6 RI-Derived Waste Disposal

The RI-derived wastes will be stored at the site in a central area. The wastes will be stored in drums labeled with waste stream and collection date. The wastes will be managed by weekly survey of storage conditions, and characterization sampling to determine disposal requirements.

Locations

Wastes generated during RI field tasks will include drill cuttings from installation of the monitoring well; water produced from equipment decontamination, well development, groundwater sampling, and aquifer testing; field clothes; and assorted trash.

Date: July 1994

Cuttings will be generated as monitoring well MW-12 is cleaned out. All cuttings will be placed in 55-gallon drums, and stored in the secured storage area to await removal by a subcontractor. It is assumed that cuttings from MW-12, and drums of decontamination pad wastes and personal protective equipment will be disposed of in a RCRA-permitted disposal facility.

Methods

One composite sample from every 10 soil drums will be tested by the disposal contractor for TCLP toxicity, reactivity, corrosivity, and ignitability to evaluate the waste-disposal requirements of the materials.

It is assumed that water generated during well development and purging and the pumping test will be treated through a rented air stripper and discharged to the ground surface onsite. CH2M HILL will arrange for the required temporary discharge permits from PaDER.

All water generated during equipment decontamination, well development, and well purging will be drummed and stored at a central location to await treatment with other water generated at the site. Sampling will be needed to verify that the discharge requirements for the treated water are met. It is assumed that no characterization beyond that already described will be needed to obtain approval for treatment and disposal.

Drilling equipment will typically be decontaminated using high-pressure steam. An area will be designated at the site for this purpose, and suitable runoff control measures will be implemented. The water generated during equipment decontamination will be drummed and treated with the other water generated during RI activities. After drilling operations are complete, the decontamination pad materials will be drummed. It is assumed that this material will be disposed of at a RCRA-permitted disposal facility. CH2M HILL will make arrangements with subcontractors for the disposal of this material and will sign all necessary manifests as a waste generator on EPA's behalf.

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Section 3

Sampling Equipment and Procedures

Section 3 presents the list of Standard Operating Procedures (SOPs) that will be used for the North Penn Area 12 site RI/FS. Table 3-1 lists the SOPs. Appendix A contains the SOPs listed in Table 3-1.

WDCR826/009.WP5

Table 3-1 STANDARD OPERATING PROCEDURES	
SOP 1	Decontamination
SOP 2	Soil Boring Drilling and Abandonment
SOP 3	Soil Sampling
SOP 4	Soil Characterization
SOP 5	Sediment Sampling
SOP 6	Surface Water Sampling
SOP 7	Groundwater Sampling
SOP 8	VOC Sampling - Water
SOP 9	VOC Sampling - Soil
SOP 10	Field Filtering
SOP 11	Field Measurement of Organic Vapors Using an HNU or OVM
SOP 12	Water-Level Measurements
SOP 13	Preserving Non-VOC Aqueous Samples
SOP 14	Field Measurement of pH and Eh
SOP 15	Field Measurement of Specific Conductance and Temperature
SOP 16	Field Measurement of Dissolved Oxygen
SOP 17	Disposal of Fluids and Solids
SOP 18	Field Rinse Blank Preparation
SOP 19	High Hazard Sample Shipping
SOP 20	Region III Sample Paperwork

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Section 4

Sample Handling and Documentation

The sample containers, preservation, and holding times for environmental samples collected in this RI are listed as follows:

- Table 4-1, liquids
- Table 4-2, solids

Concentrations and grades of preservatives to be used at the site are included in Table 4-3. The techniques to be used for sample collection and preservation are included in the SOPs.

The QA/QC requirements for sample collection are outlined in Table 4-4.

4.1 QA/QC Samples

Duplicate samples will be collected to provide a measure of the reproducibility of the laboratory procedures, and sampling procedures. The duplicate samples will be collected at a rate of 1 per 20 samples per media and laboratory.

Blanks provide a measure of cross-contamination sources, decontamination efficiency, and potential errors that can be introduced from other sources. HPLC grade water will be used for the collection of blanks prepared in the field. Two types of blanks will be collected in the field in these investigations: trip blanks and field blanks. Trip blanks monitor contamination from sources in the laboratory, during shipment, or during field storage. Field blanks indicate contamination of the sample from the sampler, sample container, sample equipment, or from the laboratory.

One VOC trip blank will be included with each daily shipment of VOC samples. The trip blanks will be prepared prior to initiation of each sampling event. The trip blanks will be prepared at the mobilization location, and will not be prepared in the field. The trip blanks will not be opened in the field following initial preparation of the samples.

One equipment blank will be included with each 20 samples. The equipment blank will be a rinse blank, collected in accordance with the procedures outlined in SOP 18. The equipment blanks will be treated in accordance with the other aqueous samples; preservatives will be added as appropriate.

One field blank will be included with each 20 samples, or at a minimum rate of 1 per event. The field blank is a measure of the purity of the water used in decontamination and resident contamination in the area of sample container storage.

Table 4-1 SAMPLE CONTAINERS, PRESERVATIVES, HOLDING TIMES FOR LIQUID SAMPLES					
Analysis	Container Type	Number of Containers Required for		Preservatives and Storage Requirements	Maximum Holding Times
		Regular Samples	Regular Sample and MS/MSD ^a		
TOC	250 ml P/G	1	2	H ₂ SO ₄ to pH <2	28 days
TCL Volatiles (RAS and DAS) plus Freon 113	40-ml glass VOA vial ^b	3	9	HCL in 2 of 3 ^{c,d} 4°C	7 days w/o HCL, 14 days w/HCL
TCL Semivolatiles (BNA) and TCL Pest/PCBs	4-liter amber glass bottle ^c -or- 2-liter amber glass bottle ^c	1 -or- 2	2 -or- 4	4°C ^d	7 days to extraction; 40 days after extraction
TAL Metals	1-liter plastic bottle	1	2	HNO ₃ to pH <2	180 days (6 mo); Hg, 28 days
TAL Cyanides	1-liter plastic bottle	1	3	NaOH to pH >12 ^d	14 days
Alkalinity	1-liter plastic bottle	1	2	4°C	14 days
TSS	250 ml P/G	1	3	Cool to 4°C	7 days
Hardness	250 ml P/G	1	2	HNO ₃ to pH <2	28 days
Notes: P/G = polyethylene or glass 4-liter or 1-gal 2-liter or 80-oz 1-liter or 1-quart 500-ml or 1-pint ^a Lab QC samples will be taken once for every 20 samples of the same matrix. These consist of MS/MSD (organics) and spike/duplicate (inorganic) samples. Lab QC samples will be identified on sample labels and chain of custody forms. ^b Teflon lined cap or septum. ^c Preserve 2 of each 3 of the VOC containers and clearly mark the preserved vials. ^d If residual chlorine is present (treated drinking water or treatment plant effluent) the following dechlorinators must be added prior to preservation: BNA/Pest/PCB - 10% sodium thiosulfate solution VOC, CN - ascorbic acid					

Table 4-2 SAMPLE CONTAINERS, PRESERVATIVES, HOLDING TIMES FOR SOLID SAMPLES					
		Number of Containers Required for			
Analysis	Container Type	Regular Samples	Regular Sample and MS/MSD ^a	Preservatives and Storage Requirements	Maximum Holding Times
TOC Organics	3 oz. wide- mouth glass jar	1	2	4°C	28 days
TCL Volatiles (VOC, VOA) plus Freon 113	40 ml glass VOA vial ^b	2	6	4°C	7 days
TCL Semivolatiles (BNA) and TCL Pest/PCBs	6 oz. glass jar ^b	1	2	4°C	7 days to extraction; 40 days after extraction
TAL Metals	6 oz. jar	1	2	4°C	180 days (6 mo); Hg, 26 days
TAL Cyanides	6 oz. jar	1	2	4°C	14 days
Grain Size	8 oz. jar	1	1	Unpreserved	Not Applicable
Notes: ^a Lab QC samples will be taken once for every 20 samples of the same matrix. These include MS/MSD (organics) and spike/duplicate (inorganic) samples. Lab QC samples will be identified on sample labels and chain-of-custody forms. ^b Teflon lined cap or septum.					

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Table 4-3 PRESERVATIVES	
Preservatives	Concentration
HCL	1:1
HNO ₃	25%
H ₂ SO ₄	Concentrated
NaOH	10N
All preservatives will be minimum reagent grade chemicals.	

WDCR826/013.WP5/2

Table 4-4
SUMMARY OF QC SAMPLES AND OFFSITE ANALYSES

Matrix	Analyses and Analytical Methods	Samples	Field Duplicates	Total Field, Equipment, and Trip Blanks	MS MSD Samples	Total Samples
Residential Drinking Water	TCL: Low Level Volatiles plus Freon 113 (SAML COWA)	71	4	15	4	94
Groundwater	TCL: Low Level Volatiles plus Freon 113 (SAML COWA)	25	2	15	2	44
	TCL: Semivolatile organic compounds (OLM01)	25	2	4	2	33
	TCL: Pesticides and PCBs (OLM01)	25	2	4	2	33
	TAL: Metals total (ILM01)	25	2	4	2	33
	TAL: Metals dissolved (ILM01)	25	2	4	2	33
Surface Water	TCL: Low Level Volatiles plus Freon 113 (SAML COWA)	4	1	4	1	10
	TCL: Semivolatile organic compounds (OLM01)	4	1	2	1	8
	TAL: Metals total (ILM01)	4	1	2	1	8
	TAL: Metals dissolved (ILM01)	4	1	2	1	8
	TSS: (EPA 160.2)	4	1	2	1	8
	Hardness (EPA 130)	4	1	2	1	8
	Alkalinity (EPA 310.1)	4	1	2	1	8
		4	1	2	1	8
Sediment	TCL: Volatiles plus Freon 113 (OLM01)	4	1	4	1	10
	TCL: Semivolatile organic compounds (OLM01)	4	1	2	1	8
	TCL: Pesticides and PCBs (OLM01)	4	1	2	1	8
	TAL: Metals total (ILM01)	4	1	2	1	8
	TOC (EPA 415.1)	4	1	2	1	8
	Grain Size (ASTMD422)	4	1	0	0	5
Soil	TCL: Volatiles plus Freon 113 (OLM01)	24	2	19	2	47
	TCL: Semivolatile organic compounds (OLM01)	24	2	4	1	31
	TCL: Pesticides and PCBs (OLM01)	4	1	2	1	8
	TAL: Metals (ILM01)	4	1	2	1	8

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A field blank is collected by transferring water from the laboratory container into sample containers. The field blanks will be treated in accordance with the other aqueous samples; preservatives will be added as appropriate.

One matrix spike and one matrix spike duplicate (MS/MSD) sample will be collected for every 20 field samples. The MS/MSD samples are collected for laboratory quality control. The MS/MSD samples will be collected to ensure that each laboratory used for sample analysis through the CLP will receive one MS/MSD sample for each 20 field samples sent to that laboratory.

4.2 Chain-of-Custody

Sample possession will be traceable through collection, preparation, shipping, and analysis. The principal documents used to identify and to document sample possession are:

- Chain of custody records
- Sample identification tags
- Sample labels
- Air bills (e.g., Federal Express)
- Field notebooks
- Sample collection database
- Shipping logs

The field sampling personnel who perform the sample collection and preparation will assume responsibility for the care and custody of the samples until they are dispatched properly. A chain of custody record will accompany each sample shipment from the field to the analytical laboratory at all times. The chain of custody procedures and sample management and documentation requirements of EPA Region III are outlined in SOP 20.

The information included in SOP 20 is the designation of samples with the CLP sample numbers, shipping protocol, bottle labeling requirements, and shipping notification requirements. The North Penn Area 12 site will also use a spreadsheet record of sample collection, shipment, and analysis. The spreadsheet will be updated at a minimum weekly and will serve as sample tracking for the samples collected at the site. Use of the sample tracking spreadsheet will enable sample designators to be electronically transferred into the EDMS database which will be used at the site for collection and management of the analytical data.

The sample tracking spreadsheet will at a minimum include:

- Field sample identification
- CLP sample designations
- Sample collection date
- Sample collection time

- Media of sample
- Designation of QC status
- Sample depth
- Location designators

4.3 Sample Packing and Shipment

The samples will be placed in the appropriate bottles and sample containers as listed in Tables 4-1 and 4-2. Sample packaging and shipment will be according to the procedures outlined in SOP 20. Sample numbers for tracking through the CLP will be provided by the SMO and will be assigned in the field. Sample shipping procedures for samples classified as high hazard samples are included SOP 19.

Samples for organics analysis will be shipped no more than 2 days after sample collection. Samples for some inorganic compounds may be held for up to 1 week after sample collection. Samples will be shipped by Federal Express Priority 1 Overnight Service. Those samples which do not require temperature to be controlled at 4 degrees C may be shipped using Federal Express Government Overnight Service.

Sample shipping will be reported to the CRL daily following the procedures outlined in SOP 20. Sample shipping information may be provided to CRL by fax and confirmed through daily telephone conversations with CRL.

4.4 Documentation

Personnel Training

All CH2M HILL project sampling personnel will have successfully completed the 40-hour Hazardous Waste Site Health and Safety Training Course. At least 1 person who has successfully completed the American Red Cross standard First Aid Course and the Basic Life Support Course in Cardiopulmonary Resuscitation will be onsite during sampling. Onsite personnel will attend a briefing on site specific health and safety hazards before working at the site.

Key field sampling personnel will review the SAP, HSP, and the North Penn Area 12 Work Plan before conducting site activities.

Log Books

Field notebooks (hand field survey books) used by field personnel will record pertinent field information and describe sampling procedures. Information will be entered in waterproof ink and written in sufficient detail so that a history of the sampling event can be reconstructed.

Notebooks will be assigned to field personnel and stored in a secure location when not in use. After project completion, these documents will be retained in the project files. The pages of each notebook will be numbered.

The cover of each notebook will indicate the following:

- Project name
- Logbook number
- Start date
- End date

Notebook entries will contain several types of information. At the beginning of each daily entry, the field personnel will record the date, start time, current weather, names of all field personnel, level of personal protection, names of any visitors, and visitor's purpose. Difficulties, accidents, incidents, or deviations from the work plan or SAP will be recorded. Each page in the log book should be numbered. The bottom of each page should be initialed by the person making entries. Each line on a page should be used or, if not used, crossed out, initialed, and dated.

All measurement made during field activities will be recorded. Corrections will be made by drawing a single line through the error and initialing and dating the correction. Information will not be erased or rendered unreadable. Wherever a sample is collected or a measurement made, a detailed description of the location of the station will be recorded.

Equipment used to obtain data will be identified. Calibration information on the sampling and measuring equipment used in the field will be recorded in a designated calibration log book. The calibration shall identify calibration equipment, calibrated equipment, calibration standards used, span or other calibration readings, and person performing the calibration. The equipment used to collect samples also will be noted. Field parameters measured during sample collection will be recorded.

The information recorded to identify the sample will include sample location, CH2M HILL sample name, CLP sample numbers, sample time, and sample date.

Photographs

Photographs will be taken at a representative group of sampling locations, and other field activities. Each photograph will be logged and described in a field logbook. Each entry will include the time, date, location, and description of objects in the photograph. The film roll and frame number should be noted. To facilitate identification of the photographs in each roll, the first shot on each roll should identify the site, project, roll number, start date, and photographer. Where possible the photographs should include a familiar object for scale.

The camera to be used for site activities should record the photo date.

4.5 Sample Designation

Sample Numbers

Samples collected during RI field activities will be designated by a unique sample number according to the matrix being sampled. The designation of sample numbers will be concurrent with designation of sampling location. A spreadsheet will be used to maintain a correlation between sample numbers and sampling location.

The sample numbers used for tracking through the project will be based on the following alpha numeric system:

Sample Number X-#-###

where: X = Media identifier
 # = Sampling team code
 ### = A sequential sample number

The media identifiers for the projected sampling are listed below:

A	Groundwater Sample
B	Surface Water Sample
C	Sediment
D	Residential Drinking Water
E	Soil
F	Duplicate
G	Equipment Blank
H	Field Blank
I	Trip Blank

Following the media designator each sample will be assigned a 4 digit number. The number will be broken into two pieces. The first digit will be a sampling team designation. It is anticipated that not more than 9 teams will collect samples at the site, so the sampling team designations will be from 1 through 9. The assignment of sampling teams will be made in the field.

The sampling team identifier will be followed by a three digit sample number. Each team will assign sequential sample numbers.

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CH2M HILL HEALTH AND SAFETY PLAN

This plan will be kept onsite during field activities and will be reviewed and updated as necessary. This plan adopts, by reference, the standards of practice (SOP) contained in the CH2M HILL *Waste Management and Industrial Processes Discipline Health and Safety Manual, Volumes 1 and 2*, and other applicable CH2M HILL SOPs as appropriate. The Site Safety Coordinator (SSC) is to be familiar with these SOPs. In addition, this plan adopts procedures contained in the work plan for the project.

1.0 PROJECT INFORMATION AND DESCRIPTION

CLIENT OR OWNER: U.S. EPA Region III

PROJECT NO: MAE63149.PP.QS

PROJECT MANAGER: Stephen Brand

OFFICE: WDC

-SITE NAME: North Penn Area 12 Superfund Site

SITE ADDRESS: 1547 Trooper Road, Worcester Township, Montgomery County, Pennsylvania

DATE HEALTH AND SAFETY PLAN PREPARED: April 30, 1994

DATE(S) OF INITIAL VISIT: 1987

DATE(S) OF SITE WORK: May 15, 1994, to June 30, 1995

SITE ACCESS: The North Penn Area 12 site is accessible by public roads as shown in Figure 1-2. The site is not fenced in and serves commercial purposes.

SITE SIZE: Approximately 50 acres.

SITE TOPOGRAPHY: Gently rolling, with low-lying ridges and valleys.

SITE DESCRIPTION AND HISTORY: The site is located in Worcester Township, Pennsylvania, in the southeastern portion of the state. North Penn Area 12 is one of six RI/FS studies being performed by CH2M HILL in Montgomery County. For all areas the presence of VOC contamination in wells was used as the basis of NPL listing. Area 12 contaminants identified to date are trichloroethene (TCE), 1,1,1-trichloroethane (TCA), Freon-113, 1,1-dichloroethene, vinyl chloride, bis (2-Ethylhexyl) phthalate, arsenic, and beryllium.

The North Penn Area 12 site was most recently (since 1987) operated by Transcoil Incorporated, a subsidiary of Eagle-Picher Industries, which manufactured electric motors at the site. The industrial history of the site dates to 1952. Prior to 1952, the property was operated as a horse farm.

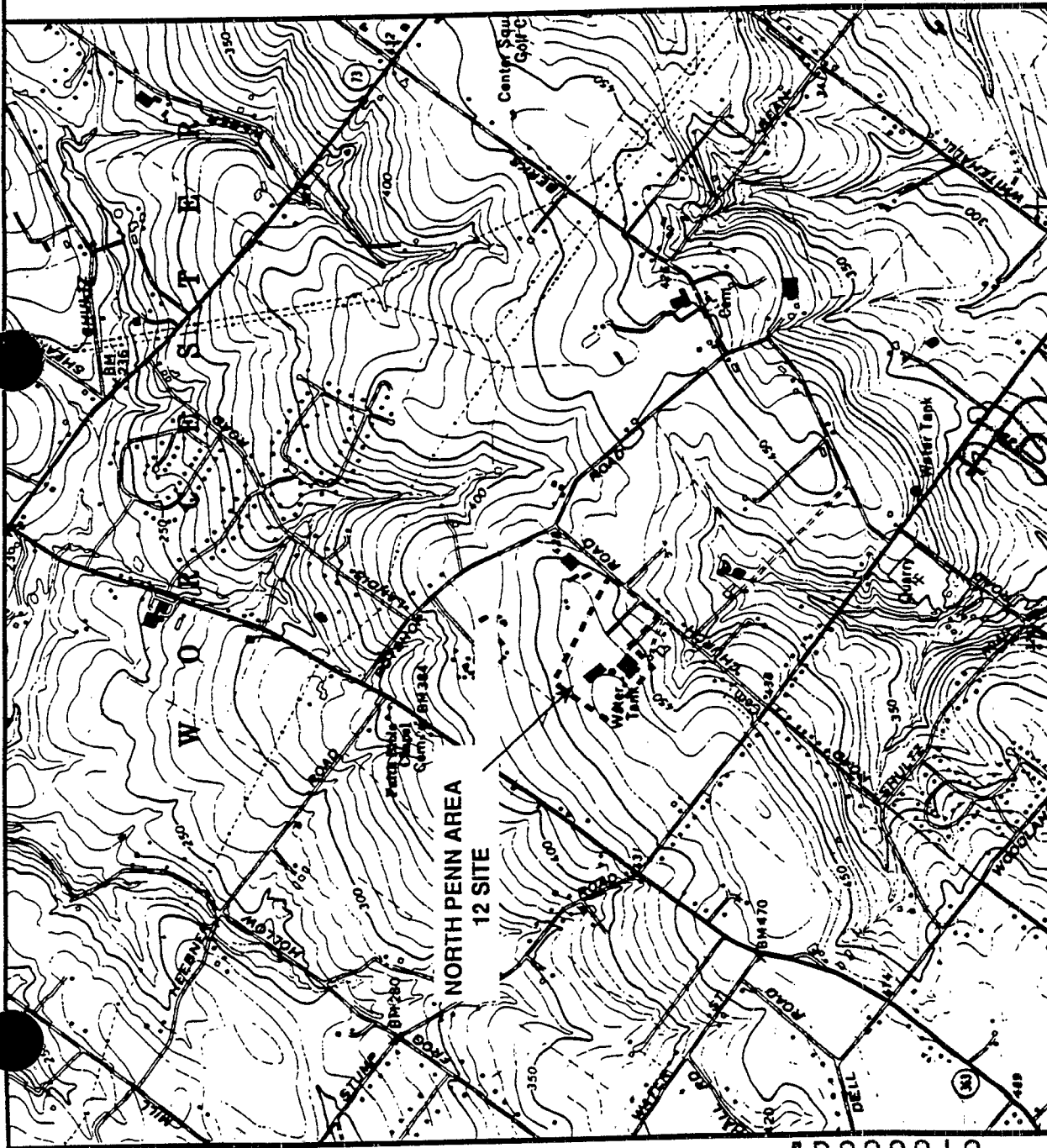
Various environmental investigations have been conducted at the site beginning in 1979 when the Pennsylvania Department of Environmental Resources (PADER) identified the facility as a potential source of trichloroethene (TCE) and 1,1,1-trichloroethane (TCA) in the onsite and offsite groundwater.

The site was proposed for inclusion on the National Priorities List (NPL) in 1987 as a result of these investigations. In 1989, Transcoil/Eagle-Picher, the potentially responsible party (PRP) voluntarily entered into a consent agreement with EPA to take the lead in conducting an RI/FS at the site. The PRP contracted Environmental Resources Management, Inc. (ERM) of Exton, Pennsylvania, to perform this work. A final RI/FS work plan was submitted to Region III on May 18, 1990, and was subsequently approved and work commenced.

RI/FS activities halted on January 7, 1991, when Eagle-Picher filed for relief under Chapter 11 of the bankruptcy code. At the time of this filing, field investigation activities pertaining to the RI/FS were in progress and no final or draft documents had been submitted or prepared.

In accordance with the consent agreement, the Chapter 11 filing resulted in the Transcoil site becoming a federal-lead Superfund site. Region III took over the site and assigned the task of completing the RI/FS activities to CH2M HILL under the previously referenced contract and work assignment.

Figure 1-1 provides the location of the site.



Source: USGS 7.5 minute Quadrangle Map
(Lansdale, PA)

0 1000 2000
Scale in Feet

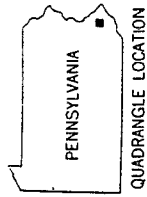


Figure 1-1
SITE LOCATION
North Penn Area 12

AR000810

2.0	PROJECT ORGANIZATION AND TASKS TO BE PERFORMED UNDER THIS PLAN						
2.1	PROJECT ORGANIZATION						
	<table> <tr> <td>Site Manager:</td><td>Stephen Brand</td></tr> <tr> <td>Field Team Leader, Field Analytical Manager:</td><td>Stephen Brand</td></tr> <tr> <td>Sample Collectors:</td><td>Don Martinson Mike Showalter Darren Braccia</td></tr> </table>	Site Manager:	Stephen Brand	Field Team Leader, Field Analytical Manager:	Stephen Brand	Sample Collectors:	Don Martinson Mike Showalter Darren Braccia
Site Manager:	Stephen Brand						
Field Team Leader, Field Analytical Manager:	Stephen Brand						
Sample Collectors:	Don Martinson Mike Showalter Darren Braccia						
2.2	DESCRIPTION OF TASKS						
	<p>Water levels will be monitored monthly in several wells. The preliminary wetlands assessment will be performed for the adjacent Nike Site and wetlands area D. Groundwater samples will be collected from residential wells in the area. Well installation of MW-12 will be completed on the site. Installation will include borehole geophysical logging of MW-12. Production Well T-6 will also undergo borehole geophysical logging. Wells MW-6 through MW-12 will be developed. The monitoring wells will be surveyed for vertical and horizontal control. The onsite buildings will also be surveyed for horizontal control. An estimated 13 geoprobe soil borings will be sampled on the Transicoil property and neighboring Hitchens property. An estimated 45 geoprobe soil borings will be sampled on the former Nike Missile Battery Control Area. Selected samples from both areas will be analyzed for VOCs in an onsite laboratory. Locations will be selected and sampled for fixed laboratory analysis. The samples chosen for fixed laboratory analysis from the Transicoil property will be analyzed for full TCL and TAL analyses. The fixed laboratory samples chosen from the Hitchens property and Nike Park will be analyzed for TCL volatiles and CFCs. If VOCs are detected in any sample from the Hitchens property or Nike Park, the sample will also be analyzed for complete TCL and TAL analyses. One round of groundwater samples will be collected from the monitoring well network. Extended water level monitoring and a long-term aquifer test will be performed. Surface water and sediment samples will be collected during a precipitation event.</p>						
2.3	DESCRIPTION OF SUBCONTRACTORS						
	<p>Subcontractors will participate in the following field activities:</p> <ul style="list-style-type: none"> • Geoprobe sampling • Drilling • Surveying <p>Soil borings and sampling will be conducted by a Geoprobe company subcontracted by CH2M HILL. Completion of monitoring well MW-12 and development of MW-6 through MW-12, will be conducted by a drilling company subcontracted by CH2M HILL. Subcontractor contact names and phone numbers will be added to or maintained with this plan before subcontractor begins site work.</p>						

2.4 DESCRIPTION OF CONTRACTORS

The USGS will conduct the borehole geophysical logging. CH2M HILL is to inform USGS personnel of site hazards that are under CH2M HILL's control (e.g., CH2M HILL task creates a hazard that USGS personnel may be exposed to). USGS personnel are solely responsible for safety and health programs, practices, and procedures applicable to their work. CH2M HILL is not responsible for USGS health and safety, and as such this health and safety plan does not cover USGS personnel.

3.0 HAZARD EVALUATION AND CONTROL

3.1 HEAT AND COLD STRESS (REFERENCE CH2M HILL SOP HS-09)

3.1.1 GUIDELINES FOR WORKING IN TEMPERATURE EXTREMES WHILE WEARING PERSONAL PROTECTIVE EQUIPMENT (PPE)

Temperature	Work Cycle	Rest Cycle	Control Measures
<32° F or <55° F & raining	2 hrs	15 min	Review cold stress in safety meeting. Rest in a warm area. Drink at least 8 ounces of warm non-caffeinated, non-alcoholic beverage at each rest break. Schedule a mid-day lunch break of at least 30 minutes in a warm area to begin not later than 5 hours after startup.
72° to 77° F	2 hrs	5 min	Review heat stress in safety meeting. Take resting pulse rate before beginning work. Drink 8 ounces of cool water before beginning work, and 4 ounces at rest break. Have ice available.
77° to 82° F	2 hrs	5 min	As above, but seated rest break. Monitor pulse rate. (See below.)
82° to 87° F	60 min	15 min	As above, but rest area to be shaded.
87° to 90° F	30 min	15 min	As above. Try to provide a shaded work area.
>90° F	15 min	15 min	As above. Provide a shaded area with seats in the work area for team members to use as needed. Try to reschedule work to avoid mid-day heat.

PULSE CRITERIA. Take resting radial (wrist) pulse at start of work day; record it. Measure radial pulse for 30 seconds as rest period begins. Pulse not to exceed 110 beats per minute (bpm), or 20 bpm above resting pulse. If pulse exceeds this criteria, reduce work load and/or shorten the work cycle by one third, and observe for signs of heat stress. No team member is to return to work until his/her pulse has returned to <110 bpm, or resting pulse +20 bpm.

3.1.2 SYMPTOMS AND TREATMENT OF HEAT AND COLD STRESS

Heat Stroke	Heat Exhaustion	Frostbite	Hypothermia
Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high body temperature.	Pale, clammy, moist skin; profuse sweating; weakness; normal temperature; headache; dizzy; vomiting.	Blanched, white, waxy skin, but tissue resilient; tissue cold and pale.	Shivering, apathy, sleepiness; rapid drop in body temperature; glassy stare; slow pulse; slow respiration.
Cool victim rapidly by soaking in cool (not cold) water. Get medical attention immediately!!	Remove victim to a cool, air conditioned place. Loosen clothing, place in head low position. Have victim drink cool (not cold) water.	Remove victim to a warm place. Rewarm area quickly in warm (not hot) water. Have victim drink warm fluids--not coffee or alcohol. Do not break any blisters. Elevate the injured area and get medical attention.	Remove victim to a warm place. Have victim drink warm fluids--not coffee or alcohol. Get medical attention.

3.2 PHYSICAL (SAFETY) HAZARDS AND CONTROLS (REFERENCE CH2M HILL SOP HS-03)

Hazard	Engineering or Administrative Controls
Flying debris/objects	Provide shielding and PPE.
Noise > 85 dBA	Noise protection and monitoring required.
Steep terrain/unstable surface	Brace and shore equipment.
* Build-up of explosive gases	Provide 20 lb A,B,C fire extinguisher and ventilation.
Build-up of static electricity	No spark sources within 50 feet of an excavation, heavy equipment, or UST removal. Ground as appropriate.
Gas cylinders	Make certain gas cylinders are properly anchored and chained. Keep cylinders away from ignition sources.
High pressure hose rupture	Check to see that fitting and pressurized lines are in good repair before using.
Electrical shock	Make certain third wire is properly grounded. Do not tamper with electrical wiring unless qualified to do so.
Suspended loads	Work not permitted under suspended loads.
Moving vehicles	Back-up alarm required for heavy equipment. Observer remains in contact with operator and signals safe back-up. Personnel to remain outside of turning radius.
Overhead electrical wires	Heavy equipment (e.g. drill rig) to remain at least 15 feet from overhead powerline for powerlines of 50 kV or less. For each Kv > 50 increase distance 1/2 foot.
Buried utilities, drums, tanks, and so forth.	Locate buried utilities, drums, tanks, etc. prior to digging or drilling and mark location.
Slip, trip, fall hazards due to muddy work areas	Use wood pallets or similar devices in muddy work areas.
Back injury	Use proper lifting techniques, or provide mechanical lifting aids.
Confined space entry	Permit and safety plan required (reference CH2M HILL SOP HS-17).
Trenches/excavations	Make certain trench meets OSHA standard before entering. All excavations > 5 feet deep must be sloped or shored. Excavations > 4 feet deep must have a ladder every 25 feet. If not entering trench, remain 2 feet from edge of trench at all times.
Protruding objects	Flag visible objects.

3.3 PROCEDURES TO LOCATE BURIED UTILITIES

Penn One (1-800-242-1776) must be called prior to soil boring activities to mark buried utility lines.

3.4 BIOLOGICAL HAZARDS AND CONTROLS

none known

3.5 TICK BITES, LYME DISEASE, AND ROCKY MOUNTAIN SPOTTED FEVER (RMSF)

Check often for tick bites. If bitten, carefully remove tick with tweezers, making certain to remove pincers, being careful not to crush the tick. After removing the tick, wash your hands. Disinfect area, and dress. If the tick resists or cannot be completely removed, seek medical attention.

Look for symptoms of lyme disease or RMSF. Lyme: rash that looks like a "bulls-eye", with small welt in center, several days to weeks after tick bite. RMSF: Rash comprising red spots under skin, 3 to 10 days after tick bite. For both, chills, fever, headache, fatigue, stiff neck, bone pain. If symptoms appear, seek medical attention.

3.6 RADIOLOGICAL HAZARDS AND CONTROLS

Refer to the CH2M HILL *Waste Management and Industrial Processes Discipline Health and Safety Manual, Volume 2* for standards of practice for operating in contaminated areas.

Hazards	Controls
None known	

3.7 HAZARDS POSED BY CHEMICALS BROUGHT ONSITE

Refer to CH2M HILL *Hazard Communication Program Manual* which is available from the Corporate Human Resources Department in Denver. The Project Manager is to request Material Safety Data Sheets (MSDSs) from the client, or contractors and subcontractors for chemicals that CH2M HILL employees are potentially exposed to.

The chemicals that may be brought onsite by CH2M HILL employees include:

Chemical	Location
Trisodium Phosphate (TSP)	With supplies for decontamination
Alconox	With supplies for decontamination
Methanol	With supplies for decontamination
Hexane	With supplies for decontamination
Conductivity Standard	Stored with conductivity meter
pH Buffers	Store with pH meter
Isobutylene gas	Stored with OVM
Nitric Acid	In water sampling vehicle
Hydrochloric Acid	In water sampling vehicle
Sulfuric Acid	In water sampling vehicle
MSA Sanitizer	With supplies for decontamination

3.8 KNOWN CONTAMINANTS OF CONCERN

Contaminant	Location and Highest Concentration (solid media: mg/kg or liquid media: ug/l)	PEL, REL, or TLV (ppm)	IDLH (ppm)	Symptoms and Effects of Exposure	PIP
Trichloroethylene	MW-1 940 mg/l GW	50	1000 ^{ca}	Head; vertigo; vis. dist.; tremors; somn; nav; vomit; derm; irrit eyes; card arthy; pares; [carc]	9.45
1,1,1-Trichloroethane	MW-4 150 ug/l GW	350	1000	Head loss; CNS depress; poor equil; irrit eyes; derm; card arthy	11.00
1,1-dichloroethylene	MW-1 11 ug/l GW	5	NL	Irrit eyes; resp sys; CNS depress.	9.65
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	T-5 650 ug/l GW	1000	4500	Throat irritation, drowsiness, dermatitis	11.99
Vinyl Chloride	S-5 0.003 mg/kg S	1	ca	weak; abdomen pain, GI bleeding; hepatomegaly; pallor or cyan of extremities; [carc]	9.99
bis (2-Ethylhexyl) Phthalate	S-5 0.24 mg/kg S	5	NL	Irr-skin	NL
Arsenic	S-5 4 mg/kg S	0.01 mg/m ³	ca 100 mg/m ³	Ulceration of nasal septum, dermatitis GI disturbances, respiratory irritation; [carc]	NA
Beryllium	SW(1.0) 1.8 mg/kg SW	0.002 mg/m ³	Ca (10 mg/m ³)	Weakness, fatigue, weightloss; respiratory symptoms; [carc]	NA

Note 1: Appropriate value of PEL, REL, or TLV listed. Note 4: Location refers to physical location. Abbreviations specify media: Note 5: NA = Not Applicable
 Note 2: NL = no limit found in reference materials. A (AIR) D (DRUMS) F (FLYASH) GW (GROUNDWATER) L (LAGOON) TK (TANK)
 Note 3: PIP = photoionization potential S (SOIL) SL (SLUDGE) SW (SURFACE WATER)

3.9 POTENTIAL ROUTES OF EXPOSURE

DERMAL:	INHALATION:	OTHER:
Contact and splashing during sampling	Inhalation during venting of wells and sampling	None anticipated

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4.0 PERSONNEL

4.1 CH2M HILL EMPLOYEES (REFERENCE CH2M HILL SOP HS-01 AND HS-02)

Employees listed below are enrolled in the CH2M HILL chemical protection program (CPP) and meet the medical surveillance, 40-hour initial training, 3-day on-the-job experience, and 8-hour annual refresher training requirements of OSHA 29CFR1910.120. Employees designated "SSC" have received 8 hours of supervisor and 8 hours of instrument training and can serve as site safety coordinator (SSC) for the level of protection indicated. There must be one SSC present during any task performed in exclusion or decontamination zones with the potential for exposure to safety and health hazards. Employees designated "FA-CPR" are currently certified by the American Red Cross, or equivalent, in first aid and CPR. There must be one FA-CPR designated employee present during any task performed in exclusion or decontamination zones with the potential for exposure to safety and health hazards. The "buddy system" requirements of OSHA 29CFR1910.120 are to be met at all times.

Employee Name	Office	Responsibility	SSC/FA-CPR
Stephen Brand	WDC	Site Safety Coordinator/Field Team Leader	Level B SSC; FA-CPR
Darren Braccia	WDC	Sample Collector	FA-CPR
Don Martinson	WDC	Sample Collector	Level B SSC; FA-CPR
Mike Showalter	WDC	Sample Collector	Level B SSC; FA-CPR

4.2 HEALTH AND SAFETY AND FIELD TEAM CHAIN OF COMMAND AND PROCEDURES

4.2.1 CLIENT

U.S. EPA Region III
Patrick McManus, RPM
(215) 597-8257

4.2.2 CH2M HILL

Program Manager
Site Manager
Health and Safety Manager
Corporate Director of Health and Safety

Mike Tilchin/WDC
Stephen Brand/WDC
John Longo/NJO
Marty Mathamel/WDC

4.2.3 SUBCONTRACTOR

Although subcontractors may be covered by this health and safety plan, this plan does not address safety hazards that are specific to subcontractor work (e.g. drill rig safety hazards). Subcontractors are solely responsible for the safety of their personnel, including development and implementation of safety programs, practices, and procedures applicable to their work. Communications regarding health and safety are to be directed to the subcontractor-designated safety representative.

4.2.4 CONTRACTOR

Contractors are not covered by this health and safety plan, and are solely responsible for health and safety of their employees. CH2M HILL personnel are not to direct contractor health and safety. Health and safety concerns are to be directed to the contractor-designated safety representative.

5.0 PERSONAL PROTECTIVE EQUIPMENT (PPE) SPECIFICATION ¹ (REFERENCE: CHEM HILL SOP HS-07 and HS-08)							
Task	Level	Body	Foot	Head ²	Eye	Hand	Respirator
Residential well sampling Water level measurements Surface water/sediment sampling Wetlands Assessment Geophysical logging Surveying Aquifer testing	D	Work clothes or cotton coveralls	Steel toe safety boots Outer rubber boots as necessary	Hardhat	Safety glasses	Work gloves or surgical nitrile gloves Outer nitrile gloves as necessary	None required.
Monitoring well sampling and Geoprobe sampling Monitoring well installation	D	Tyvek	Steel toe safety boots and outer rubber boot covers	Hardhat	Safety glasses	Inner surgical nitriles Outer nitriles	None required
Task requiring upgrade	C	Polycoated Tyvek	Steel toe safety boots and outer rubber boot covers	Hardhat Ear protection	Not applicable	Inner surgical nitriles Outer nitriles	APR, full face, MSA Ultratwin or equivalent. Cartridges: GMC-H, or equivalent
Note 1: Modifications: As indicated above. Note 2: The SSC shall specify hardhat areas (e.g., around heavy machinery).							

5.1 REASONS TO UPGRADE OR DOWNGRADE LEVEL OF PROTECTION	
Upgrade	Downgrade
<ul style="list-style-type: none"> Request of individual performing task. Change in work task that will increase contact or potential contact with hazardous materials. Occurrence or likely occurrence of gas or vapor emission. Known or suspected presence of dermal hazards. Instrument action levels (Section 6.0) exceeded. 	<ul style="list-style-type: none"> New information indicating that situation is less hazardous than originally thought. Change in site conditions that decreases the hazard. Change in work task that will reduce contact with hazardous materials.

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6.0 AIR MONITORING EQUIPMENT SPECIFICATION (REFERENCE CH2M HILL SOP HS-06)				
Instrument	Tasks	Action Levels	Frequency	Calibration
Photoionization Detector (PID): PI-101, 11.7 eV lamp	Residential well sampling Water level measurements Geophysical logging Aquifer testing Monitoring well sampling Geoprobe sampling Monitoring well installation	0-1 ppm ^{ab1} 1-5 ppm ^{ab} > 5 ppm ^{ab} Level D Level C Stop work & re-evaluate; may require Level B	When venting well head, periodically during sampling	Daily
Dust: Visible	All tasks	No visible dust Visible dust Level D Stop work & re-evaluate; may require Level C	Continuous	Not applicable
Note 1: ab = above background				

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6.1 CALIBRATION SPECIFICATION

Instrument	Gas	Span	Reading	Method
PID: HNU, 10.2 ev probe	100 ppm isobutylene	9.8 ± 2.0	55 ppm	1.5 l/m reg T-tubing 0.25 l/m reg direct tubing
PID: HNU, 11.7 ev probe	100 ppm isobutylene	5.0 ± 2.0	68 ppm	1.5 l/m reg T-tubing 0.25 l/m reg direct tubing

6.2 ADDITIONAL AIR MONITORING**Method and Description:**

Not applicable

Personnel:

Not applicable

Areas:

Not applicable

Results to be interpreted by:

Not applicable

7.0 DECONTAMINATION SPECIFICATION (REFERENCE CH2M HILL SOP HS-13)

Personnel	Sample Equipment	Heavy Equipment
• Boot wash/rinse	• Wash/rinse equipment	• Power wash
• Glove wash/rinse	• Solvent rinse equipment	• Steam clean
• Outer glove removal	• Solvent disposal method: Drummed and properly disposed.	• Water disposal method: Contained and treated onsite.
• Body suit removal		
• Inner glove removal		
• Respirator removal		
• Hand wash/rinse		
• Face wash/rinse		
• Shower ASAP		
• PPE disposal method: Drummed and properly disposed.		
• Water disposal method: Contained and treated onsite.		

8.0 SPILL CONTAINMENT PROCEDURES

Although CH2M HILL is not handling large quantities of liquid materials, there is a potential that sample preservatives or purge water could spill. In the event that a liquid spills, sorbent material will be used to contain the spill. Affected media will be placed in drums and will be disposed of in accordance with state and federal regulations.

In the event that oil or hydraulic fluid spills or leaks from heavy equipment, the affected soil will be excavated until visually stained material is removed. This material will be placed in drums and disposed of in accordance with applicable regulations.

9.0 CONFINED SPACE ENTRY

No confined space entries are anticipated. If they must be conducted an additional health and safety plan and a permit will be developed prior to entering the confined space. (Refer to CH2M HILL SOP HS-17, contained in the *Waste Management and Industrial Processes Discipline Health and Safety Manual, Volume 1*.)

10.0 WORK PROCEDURES

10.1 WORK PRACTICES

- No spark sources within exclusion or decontamination zones.
- Avoid visibly contaminated areas.
- No eating, drinking, or smoking in contaminated areas, or exclusion or decontamination zones.
- SSC to establish areas for eating, drinking, smoking.
- No contact lenses in exclusion or decontamination zones.
- No facial hair that would interfere with respirator fit if Level C or B is anticipated.
- Site work will be performed during daylight hours whenever possible. Any work conducted during hours of darkness will require enough illumination intensity "to read a newspaper without difficulty."

10.2 SITE CONTROL MEASURES

- Site safety coordinator (SSC) to conduct site safety briefing (see below) before starting field activities, or as tasks and site conditions change.
- SSC records safety briefing attendance in logbook, and documents topics discussed.
- Post OSHA job site poster in a central and conspicuous location at the site.
- Determine wind direction.
- Establish work zones: support, decontamination, and exclusion zones, and delineate work zones with flagging or cones as appropriate. Support zone upwind of site.
- Establish decontamination procedures, including respirator decontamination procedures, and test.
- Utilize access control at the entry and exit from each work zone.
- Chemicals to be stored in proper containers.
- MSDSs are available for onsite chemicals employees exposed to.
- Establish onsite communications. These should consist of:
 - Line of sight/hand signals
 - Air horn
 - Two-way radio or cellular phone if available
- Establish emergency signals. For example:
 - Grasping throat with hand--EMERGENCY--HELP ME
 - Grasping buddy wrist--LEAVE AREA NOW
 - Thumbs up--OK, UNDERSTOOD
 - Two short blasts on air horn--ALL CLEAR
 - Continuous air horn--EMERGENCY--EVACUATE
- Establish offsite communications.
- Establish "buddy" system.
- Establish procedures for disposal of material generated onsite.
- Initial air monitoring conducted by SSC in appropriate level of protection.
- SSC to conduct periodic inspections of work practices to determine effectiveness of this plan. Deficiencies to be noted, reported to DHSM or RHSM, and corrected.
- Site safety briefing topics: general discussion of health and safety plan; site specific hazards; location of work zones; PPE requirements; equipment; special procedures; emergencies.

11.0 EMERGENCY RESPONSE PLAN (REFERENCE CH2M HILL SOP HS-12)

11.1 PRE-EMERGENCY PLANNING

The SSC performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with the facility and local emergency service providers as appropriate.

- Locate nearest telephone to the site and inspect onsite communications.
- Locate chemical, safety, radiological, biological hazards.
- Confirm and post emergency telephone numbers and route to hospital.
- Post site map marked with location of emergency equipment and supplies.
- Review emergency response plan for applicability to any changed site conditions, alterations in onsite operations, or personnel availability.
- Evaluate capabilities of local response teams.
- Where appropriate and acceptable to the client, inform emergency room/ambulance service and emergency response teams of anticipated types of site emergencies.
- Designate one vehicle as the emergency vehicle; place hospital directions and map inside; keep keys in ignition during field activities.
- Inventory and check site emergency equipment and supplies.
- Review emergency procedures for personnel injury, exposures, fires, explosions, chemical and vapor releases with field personnel.
- Locate onsite emergency equipment and supplies of clean water.
- Verify local emergency contacts, hospital routes, evacuation routes, and assembly points.
- Drive route to hospital.
- Review names of onsite personnel trained in first aid and CPR.
- Review notification procedures for contacting CH2M HILL's medical consultant and team member's occupational physician.
- Rehearse the emergency response plan once prior to site activities.
- Brief new workers on the emergency response plan.

11.2 EMERGENCY EQUIPMENT AND SUPPLIES

The SSC marks the locations of emergency equipment on the site map and posts the map in the support zone.

- 20 lb ABC fire extinguisher
- Industrial first aid kit

11.3 EMERGENCY MEDICAL TREATMENT

- The SSC will assume charge during a medical emergency until the ambulance arrives, or the injured person is admitted to the emergency room.
- Prevent further injury.

- Initiate first aid and CPR.
- Call the ambulance and hospital.
- Determine if decontamination will make injury worse. Yes--seek medical treatment immediately.
- Make certain that injured person is accompanied to emergency room.
- Notify the Project Manager of the injury.
- Notify the District or Regional Health and Safety Manager.
- Notify the injured person's human resources department.
- Prepare an incident report. Submit this to the Corporate Director Health and Safety (WDC) and Corporate Human Resources Department (DEN) within 48 hours.

11.4 EVACUATION

- Evacuation routes will be designated by SSC prior to beginning of work.
- Onsite and offsite assembly points will be designated prior to beginning of work.
- Personnel will exit the exclusion zone and assemble at the onsite assembly point upon hearing the emergency signal for evacuation of the exclusion zone.
- Personnel will assemble at the offsite point upon hearing the emergency signal for a site evacuation.
- The SSC and a "buddy" will remain onsite after the site has been evacuated (if possible) to assist local responders and advise them of the nature and location of the incident.
- SSC accounts for all personnel in the onsite assembly zone.
- A person designated by the SSC (prior to work) will account for personnel at the offsite assembly area.
- The SSC is to write up the incident as soon as possible after it occurs, and submit a report to the Corporate Director Health and Safety.

11.5 EVACUATION ROUTES AND ASSEMBLY POINTS

Transicoil: Evacuate to main gate at the intersection of Church Road.

12.0 EMERGENCY RESPONSE TELEPHONE NUMBERS

SITE ADDRESS: 1547 Trooper Rd., Worcester, PA **Phone:**

Police: Worcester Township **Phone:** (610) 631-5933 (911)
Address: Worcester, Pennsylvania

Fire: Worcester Township **Phone:** (610) 584-6911 (911)
Address: Worcester, Pennsylvania

Ambulance: Norristown Ambulance Service **Phone:** 911
Address: Norristown, Pennsylvania

Water: North Penn Water Authority **Phone:** (215) 855-3617

Gas: Philadelphia Gas Company **Phone:** (215) 699-5363

Electric: Pennsylvania Power & Light Company **Phone:** (215) 723-8933

Hospital: Suburban General Hospital **Phone:** (610) 278-2000
Address: 2701 DeKalb Pike
Norristown, Pennsylvania

Route To Hospital: (Refer to map Page 20.)

From the site take a right (southwest) on Church Road. Go ~ 2/10ths of a mile. Turn left (southeast) on Stump Road which becomes Township Line Road. Follow Township Line Road for about 2-1/2 miles to Dekalb Pike (Route 202). Turn right on Route 202. Follow Route 202 for ~ 1/2-mile to the Germantown Pike intersection (Route 422). Cross Germantown Pike staying on Route 202 and Suburban General Hospital will be on your right at the intersection of Germantown Pike and Route 202.

12.1 GOVERNMENT AGENCIES INVOLVED IN PROJECT

Federal: Patrick McManus **Phone:**(215) 597-8257
U.S. EPA Region III

State: Pennsylvania Department of Environmental Resources **Phone:**(215) 832-6000

Local: **Phone:**

13.0 EMERGENCY CONTACTS**CH2M HILL Medical Consultant**

Dr. Kenneth Chase
Washington Occupational Health Associates
202/463-6698 (8 AM to 5 PM EST)
202/463-6440 (after hours answering service;
physician will return call within 30 minutes)

Occupational Physician (Regional or Local)

Dr. Laura Staton
46440 Benedict Drive, Suite 108
Sterling, VA 22170
803/444/5656

Corporate Director Health and Safety

Name: Marty Mathamel/WDC
Phone: 703/471-1441

Site Safety Coordinator (SSC)

Name: Stephen Brand
Phone: 703/471-1441

District Health and Safety Manager (DHSM)

Name: Marty Mathamel/WDC
Phone: 703/471-1441

Regional Manager

Name: Bud Ahearn
Phone: 703/471-1441 (ext. 4304)

Health and Safety Manager (HSM)

Name: John Longo
Phone: 201/316-9300

Site Manager

Name: Stephen Brand
Phone: 703/471-1441

Radiation Health Manager (RHM)

Name: George Stephens/ORO
Phone: 615/483-9032

Regional Human Resources Department

Name: Elizabeth Johnson/WDC
Phone: 703/471-1441

Client

Patrick McManus, RPM
US EPA Region III
215/597-8257

Corporate Human Resources Department

Name: Susan Thomas/DEN
Phone: 303/771-0952

If an injury occurs, notify the injured person's personnel office as soon as possible after obtaining medical attention for the injured. Notification MUST be made within 24 hours of the injury.

14.0 PLAN APPROVAL

This site safety plan has been written for use by CH2M HILL. CH2M HILL claims no responsibility for its use by others, unless specified and defined in project or contract documents. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if these conditions change.

PLAN WRITTEN BY: Stephen Brand**DATE:** 4/28/94**PLAN APPROVED BY:** John Longo/NJO**DATE:** 5/3/94**14.1 PLAN AMENDMENTS****DATE: CHANGES MADE BY:****CHANGES TO PLAN:****APPROVED:****DATE:****15.0 ATTACHMENTS TO PLAN****Attachment 1:** Employee signoff**Attachment 2:** Applicable MSDSs

Note: Once approved, a copy of this plan should be forwarded to Marty Mathamel/WDC.

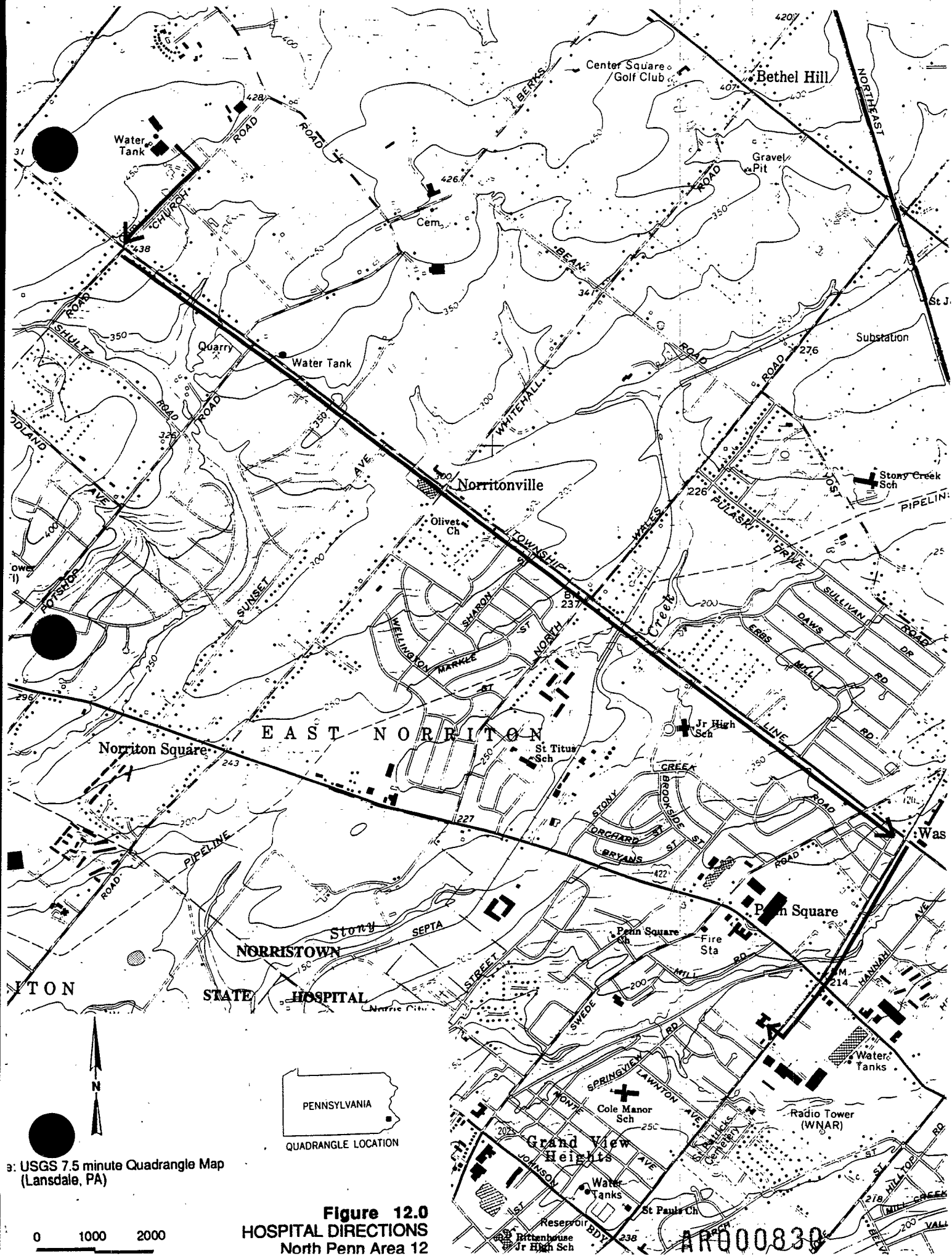


Figure 12.0
HOSPITAL DIRECTIONS
North Penn Area 12

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EMPLOYEE SIGNOFF

[illegible]

ATTACHMENT 2
APPLICABLE MSDSs

HAZARDOUS MATERIAL SAFETY DATA SHEET

SHEET 1 OF 2

Amion Research Incorporated
100 HAZCO CENTER
90 HAZCO STREET, BOSTON, MA 02129 USA
TEL: 617-242-3900

I. PRODUCT IDENTIFICATION

PRODUCT NAME	CATALOG NO.	EFFECTIVE DATE
Amion Application Solution pH 4.01 Buffer	910104 or 330004	12/4/89
HAZARDOUS COMPONENT LABELLING:	DOT	IATA
NA	NA	NA
PREPARED BY	TITLE	
<i>James F. Flynn</i>	Safety Chemist	
APPROVED BY	TITLE	
<i>Lynn Orlando</i>	Director Regulatory Matters	

II. HAZARDOUS INGREDIENTS (IDENTITY INFORMATION)

HAZARDOUS COMPONENTS * (SPECIFIC CHEMICAL IDENTITY; COMMON NAME(S))	CAS NO.	%	OSHA PEL	ACGIH TLV	LD 50
Potassium Hydrogen Phthalate (KHP)	877-21-7	1.01	None	None	NA*
Amaranth Red Dye	915-67-3	0.0005	None	None	NA
Deionized Water**	7732-18-5	98.99	NA	NA	NA

III. PHYSICAL DATA

MELTING POINT (°C)	100°C	FREEZING POINT (°C)	0°C
SPECIFIC GRAVITY (H ₂ O = 1)	1.0	VAPOR PRESSURE @	NA
pH @ °C	4.01 25°C	SOLUBILITY IN WATER, % BY WT. @	Miscible
VOLATILES, % BY WT.		EVAPORATION RATE (BUTYL ACETATE = 1)	NA
VAPOR DENSITY (AIR = 1)	NA		
APPEARANCE AND ODOR	Light red, odorless liquid		

IV. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (TEST METHOD)	Not Flammable	AUTOIGNITION TEMPERATURE	NA
FLAMMABLE LIMITS IN AIR, % BY VOLUME:	LOWER	UPPER	
	NA	NA	
EXTINGUISHING MEDIA	Any		
SPECIAL FIRE-FIGHTING PROCEDURES	None, non flammable		
UNUSUAL FIRE AND EXPLOSION HAZARDS	None		

Chemicals which are not classified as hazardous or which are not listed in the HHA guidelines (29CFR Parts 1915.2 or 1915.6) or the Massachusetts Substance List (105CMR 870.000 Appendix A), will not necessarily be listed on this form even though one or more may be a constituent of this product.

Liability is expressly disclaimed for any loss or injury arising out of the use of this information or the use of any materials designated. Safe use of the materials is the responsibility of the user.

Document No. 205487-001 Rev B

*NA = Not available/Not applicable

** = Non Hazardous Component

*** = Refers to Amaranth Red Dye

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Printed in U.S.A.
FORM HSC-630A

RION MATERIAL SAFETY DATA SHEET

ET 2 OF 2

PRODUCT NAME:

Orion Application Solution
pH 4.01 Buffer

CATALOG NO.: 910104 or 330004

V. REACTIVITY DATA

LITY: ☐ STABLE ☒ ☐ None

MPATIBILITY MATERIALS TO AVOID

HNO₃

RDOUS DECOMPOSITION PRODUCTS

None

RDOUS POLYMERIZATION: ☐ WILL NOT OCCUR ☒ ☐ None

VI. HEALTH HAZARD DATA

E(S) OF ENTRY:

INHALATION?

No

SKIN?

Yes

INGESTION?

Yes

TH HAZARDS (ACUTE AND CHRONIC)

Acute: Low hazard for acute because of low concentration of salts.

Chronic: Possible skin irritant for prolonged exposure.

INOGENICITY:

NTP?

IARC MONOGRAPHS? ***

OSHA REGULATED?

Amaranth is suspected/Not found (animal positive)

Not found

AND SYMPTOMS OF EXPOSURE

Irritation of skin

CAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

Could aggravate diseases of skin

AGENCY AND FIRST AID PROCEDURES

Wash off contact area with water. If ingested, give large amounts of
water. Consult physician.

VII. PRECAUTIONS (SAFE HANDLING AND USE)

S TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Wash down drain with excess water.

E DISPOSAL METHOD

Same as above.

AUTIONS TO BE TAKEN IN HANDLING AND STORING

Suitable for any general handling and storage. This product is not
regulated under SARA TITLE III.

R PRECAUTIONS

Hazard Ratings: Scale (0-3), health 1, flammability 0, reactivity 1,
persistence 0.

VIII. CONTROL MEASURES

IRATORY PROTECTION (SPECIFY TYPE)

None

LATION	LOCAL EXHAUST	SPECIAL
	No	No
EFFECTIVE GLOVES	MECHANICAL (GENERAL)	OTHER
	No	No
R PROTECTIVE CLOTHING OR EQUIPMENT		EYE PROTECTION
	Yes	Safety Glasses

HYGIENIC PRACTICES

No

AR0000834

M A T E R I A L S A F E T Y D A T A S H E E T
EM SCIENCE
A DIVISION OF EM INDUSTRIES
P.O. BOX 70
DEMOCRAT RD.
BOSTOWN, N.J. 08027
PREPARATION DATE: OCT 27, '89
INFORMATION PHONE NUMBER :
(609) 354-9200
CHEMTREC EMERGENCY NUMBER:
1-800-424-9300

NFPA HAZARD RATINGS

HEALTH: 0 FLAMMABILITY: 0
REACTIVITY : 0 SPECIAL HAZARDS..:

SECTION I - GENERAL INFORMATION

CATALOG NUMBER(S): BX1632 BX1635
CHEMICAL NAME.....: BUFFER SOLUTION, PH 7
TRADE NAME.....: N/A
C.A.S. NUMBER.....: SEE SECTION II
CHEMICAL FAMILY...: INORGANIC SOLUTION
FORMULA.....: WATER SOLUTION (99+% H₂O)
MOLECULAR WEIGHT.: N/A
DOT SHIPPING NAME: (NON-REGULATED)
DOT NUMBER.....: (NONE)

SECTION II - HAZARDOUS INGREDIENTS

COMPONENT	CAS#	APPROX. %	PEL (TWA)	TLV (TWA)
POTASSIUM PHOSPHATE, MONOBASIC	7778-77-0	0-1	NE	NE
SODIUM PHOSPHATE, DIBASIC	7558-79-4	0-1	NE	NE
WATER	7732-18-5	99+	NE	NE

NE = NONE ESTABLISHED

SECTION III- PHYSICAL DATA

BOILING POINT (C 760 MM HG): 100C
MELTING POINT (C).....: N/A
SPECIFIC GRAVITY(H₂O = 1).....: 1.000
VAPOR PRESSURE..(MM HG).....: N/A 20C
PERCENT VOLATILE BY VOL (X)....: 90+

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VAPOR DENSITY (AIR=1).....: N/A
EVAPORATION RATE (BUAC=1).....: N/A
SOLUBILITY IN WATER (%).....: SOLUBLE
APPEARANCE AND ODOR.....: CLEAR, ODORLESS, COLORLESS (BX1635)
YELLOW LIQUID (PX1632)

SECTION IV - FIRE & EXPLOSION HAZARD DATA

FLASH POINT (F).....: NONCOMBUSTIBLE
FLAMMABLE LIMITS LEL %.: N/A
FLAMMABLE LIMITS UEL %.: N/A
EXTINGUISHING MEDIA.....:
USE ANY SUITABLE FOR ADJACENT MATERIAL.
FIRE FIGHTING PROC.....:
NONE INDICATED
FIRE & EXPL. HAZARDS.....:
NONE INDICATED

SECTION V - HEALTH HAZARD DATA (ACUTE AND CHRONIC)

ACGIH TLV/CSHA PEL (TWA).....:
NONE ESTABLISHED
TOXICITY DATA.....:
NONE ESTABLISHED
SYMPTOMS OF EXPOSURE:
MAY IRRITATE EYES ON CONTACT.
MEDICAL COND. AGGRAVATED BY EXP: DATA NOT AVAILABLE.
ROUTES OF ENTRY.....: INHALATION, INGESTION
CARCINOGENICITY.....:
THE MATERIAL IS NOT LISTED (IARC, NTP, OSHA) AS CANCER CAUSING AGENT.
EMERGENCY FIRST AID.....:
GET MEDICAL ASSISTANCE IF ANY ADVERSE EFFECTS DEVELOP
SKIN: WASH THOROUGHLY WITH SOAP AND WATER.
EYES: IMMEDIATELY FLUSH THOROUGHLY WITH WATER FOR AT LEAST 15 MINUT
INHALATION: REMOVE TO FRESH AIR; GIVE ARTIFICIAL RESPIRATION IF
BREATHING HAS STOPPED.
INGESTION: GET IMMEDIATE MEDICAL ATTENTION; IF CONSCIOUS, GIVE
WATER FREELY.

SECTION VI - REACTIVITY DATA

STABILITY.....: YES
CONDITIONS TO AVOID: NONE INDICATED
MATERIALS TO AVOID.....: () WATER () ACIDS
() BASES () CORROSIVES () OXIDIZERS
() OTHER: NONE INDICATED

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HAZARDOUS POLYMERIZATION.: DOES NOT OCCUR
HAZARDOUS DECOMPOSITION.: NONE

SECTION VII - ENVIRONMENTAL PROTECTION PROCEDURES

SPILL RESPONSE:

DIKE SPILL, TAKE UP WITH ABSORBENT AND CONTAINERIZE FOR PROPER DISPOSAL.

EM SCIENCE SPILL-X NEUTRALIZER AND ADSORBENT AGENTS ARE RECOMMENDED FOR CHEMICAL SPILLS.

WASTE DISPOSAL: TO BE PERFORMED IN COMPLIANCE WITH ALL CURRENT LOCAL, STATE AND FEDERAL REGULATIONS.

SECTION VIII - SPECIAL PROTECTION INFORMATION

VENTILATION, RESPIRATORY PROTECTION, PROTECTIVE CLOTHING, EYE PROTECTION:

MATERIAL SHOULD BE HANDLED OR TRANSFERRED IN AN APPROVED FUME HOOD OR WITH ADEQUATE VENTILATION

PROTECTIVE GLOVES (NATURAL RUBBER, NEOPRENE, PVC OR EQUIVALENT) SHOULD BE WORN TO PREVENT SKIN CONTACT

SAFETY GLASSES WITH SIDE SHIELDS SHOULD BE WORN AT ALL TIMES

SECTION IX - SPECIAL PRECAUTIONS

HANDLING & STORAGE

STORE AT CONTROLLED ROOM TEMPERATURE

DO NOT GET IN EYES

WORK/HYGIENIC PRACTICES: WASH THOROUGHLY AFTER HANDLING. DO NOT TAKE INTERNALLY. EYE WASH AND SAFETY EQUIPMENT SHOULD BE READILY AVAILABLE.

SECTION X - OTHER INFORMATION

COMMENTS.....: NONE

REVISION HISTORY.....: 12/83, 10/27/87

A = NOT AVAILABLE:

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M A T E R I A L S A F E T Y D A T A S H E E T
EM SCIENCE
A DIVISION OF EM INDUSTRIES
111 WOODCREST
BERRY HILL, N.J. 08034-0325
PREPARATION DATE OCT 27, '87
INFORMATION PHONE NUMBER.:
(609) 354-9200
CHEMTREC EMERGENCY NUMBER:
1-800-424-9300

NFPA HAZARD RATINGS
1 HEALTH: 0 FLAMMABILITY: 0
1 REACTIVITY : 0 SPECIAL HAZARDS.: N/A

SECTION I - GENERAL INFORMATION

CATALOG NUMBER(S): BX1633 BX1636
CHEMICAL NAME.....: BUFFER SOLUTION, PH 10
TRADE NAME.....: N/A
C.A.S. NUMBER.....: N/A
CHEMICAL FAMILY...: INORGANIC SOLUTION
FORMULA.....: WATER SOLUTION OF BUFFER SALTS (99+% H2O)
MOLECULAR WEIGHT.: N/A
DOT SHIPPING NAME: N/A
DOT NUMBER.....: N/A

SECTION II - HAZARDOUS INGREDIENTS

-NONE OTHER THAN SPECIFIED PRODUCT

SECTION III- PHYSICAL DATA

BOILING POINT (C 760 MM HG): 100C
MELTING POINT (C).....: N/A
SPECIFIC GRAVITY(H2O = 1).....: 1.000
VAPOR PRESSURE..(MM HG).....: N/A N/A
PERCENT VOLATILE BY VOL (%): 99+
VAPOR DENSITY (AIR=1).....: N/A
EVAPORATION RATE (EAC=1).....: N/A
SOLUBILITY IN WATER (%): N/A
APPEARANCE AND ODOR.....: CLEAR OR GREEN ODORLESS
LIQUID

SECTION IV - FIRE & EXPLOSION HAZARD DATA

FLASH POINT (F).....: NONCOMBUSTIBLE
FLAMMABLE LIMITS LEL %.: N/A
FLAMMABLE LIMITS UEL %.: N/A
EXTINGUISHING MEDIA.....:

ANY SUITABLE FOR OTHER MATERIALS INVOLVED

MSDS-BX1633

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FIRE FIGHTING PROC.....:

NONE

FIRE & EXPL. HAZARDS....:

-NONE

SECTION V - HEALTH HAZARD DATA (ACUTE AND CHRONIC)

ACGIH TLV/OSHA PEL (TWA).....:

& PEL: NONE ESTABLISHED

TOXICITY DATA.....:

-N/A

SYMPTOMS OF EXPOSURE

-MAY IRRITATE EYES AND SKIN ON CONTACT

MAY IRRITATE G.I. TRACT ON INGESTION

MEDICAL COND. AGGRAVATED BY EXP: DATA NOT AVAILABLE.

ROUTES OF ENTRY.....: INHALATION, INGESTION OR SKIN CONTACT.

CARCINOGENICITY.....: SEE COMMENTS, SECTION X; IF NO INFORMATION APPEARS, THE MATERIAL IS NOT LISTED AS A CANCER CAUSING AGENT.

EMERGENCY FIRST AID.....:

GET MEDICAL ASSISTANCE IF ANY ADVERSE EFFECTS DEVELOP

SKIN: WASH WITH SOAP AND WATER THOROUGHLY

EYES: FLUSH THOROUGHLY WITH WATER

INGESTION: IF CONSCIOUS, INDUCE VOMITING

SECTION VI - REACTIVITY DATA

STABILITY.....: YES

CONDITIONS TO AVOID

-NONE

MATERIALS TO AVOID.....: () WATER () ACIDS

() BASES () CORROSIVES () OXIDIZERS

() OTHER (SPECIFY)- NONE

HAZARDOUS POLYMERIZATION.: DATA NOT AVAILABLE.

HAZARDOUS DECOMPOSITION.: -NONE

SECTION VII - ENVIRONMENTAL PROTECTION PROCEDURES

SPILL RESPONSE:

-TAKE UP WITH ABSORBENT AND CONTAINERIZE

FLUSH AREA WITH WATER

WASTE DISPOSAL: TO BE PERFORMED IN COMPLIANCE WITH ALL CURRENT LOCAL, STATE AND FEDERAL REGULATIONS.

SECTION VIII - SPECIAL PROTECTION INFORMATION

VENTILATION, RESPIRATORY PROTECTION, PROTECTIVE CLOTHING, EYE PROTECTION

-MATERIAL SHOULD BE HANDLED OR TRANSFERRED IN AN APPROVED FUME

HOOD OR WITH ADEQUATE VENTILATION

PROTECTIVE GLOVES (NATURAL RUBBER, NEOPRENE, PVC OR EQUIVALENT)

SHOULD BE WORN TO PREVENT SKIN CONTACT

SAFETY GLASSES WITH SIDE SHIELDS SHOULD BE WORN AT ALL TIMES

SECTION IX - SPECIAL PROTECTION INFORMATION

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HANDLING & STORAGE

-KEEP CONTAINER CLOSED

STORE AT CONTROLLED ROOM TEMPERATURE

DO NOT BREATHE SOLUTION MIST

DO NOT GET IN EYES

AVOID PROLONGED OR REPEATED SKIN CONTACT

DO NOT TAKE INTERNALLY

WORK/HYGIENIC PRACTICES: WASH THOROUGHLY AFTER HANDLING. DO NOT TAKE
INTERNALLY. EYE WASH AND SAFETY EQUIPMENT SHOULD BE READILY AVAILABLE.

SECTION X - OTHER INFORMATION

COMMENTS.....:

-PRODUCT CONTAINS LESS THAN 1% OF NON-HAZARDOUS BUFFER SALT
BX1633 ALSO CONTAINS LESS THAN 0.01% OF INERT INDICATOR

REV. 2/97

N/A

REVISION HISTORY.....: 12/01/83, N/A
OCT 27, '97

N/A = NOT AVAILABLE:

MSDS-BX1633

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MATERIAL SAFETY DATA SHEET

CORPORATE RESEARCH & DEVELOPMENT

SCHENECTADY, N. Y. 12305

Phone: (518) 385-4085

DIAL COM: 8*235-4085

MS
MATERIALS
SERVICES
INFORMATION

No. 43

TRISODIUM PHOSPHATE
DODECAHYDRATE

Date November 1978

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: TRISODIUM PHOSPHATE DODECAHYDRATE

DESCRIPTION: Crystallizes from water as $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$ and can exist as several hydrate forms, depending on processing, and as the anhydrous salt.

OTHER DESIGNATIONS: TSP, Trisodium Orthophosphate, Sodium Phosphate, Tribasic, Tertiary Sodium Phosphate, GE Material D4K1, ASTM D538, CAS# 007 601 549

MANUFACTURER: Available from several suppliers, including FMC Corporation, Monsanto Co., Stauffer Chemical Co., and Olin Corp.

SECTION II. INGREDIENTS AND HAZARDS

Trisodium Phosphate (as $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$)

> 97

HAZARD DATA

No TLV established*

*Under OSHA inert dust limits it can be assumed that air-borne particulate, not otherwise controlled, is limited to a maximum of 5 mg/kg of respirable dust; however, this level may not be adequate to prevent irritation with this material.

($\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$)
Rat, Oral
LD₅₀ 7400 mg/kg

SECTION III. PHYSICAL DATA

Boiling point ----- -11 H_2O at 100 C
(decomposes)

Specific gravity (20/4 C) ----- 1.62

pH of 1% water solution at 25 C - ca 12

Melting point, deg C -- >73.3 (dec)

Molecular weight ----- 380.1

Solubility, g/100g H_2O :

at 0 C ----- 1.5

at 15 C ----- 28.3

at 70 C ----- 157

Appearance & Odor: White or colorless crystalline solid (also as powder flake, granules, etc.).
No odor.

SECTION IV. FIRE AND EXPLOSION DATA

LOWER UPPER

Flash Point and Method

Autoignition Temp.

Flammability Limits in Air

None

None

None

Extinguishing Media: Use that which is appropriate to the surrounding fire; this material is non-combustible.

In a fire situation at high temperature phosphates can emit highly toxic phosphorus oxide fumes. Firefighters should use self-contained breathing apparatus.

SECTION V. REACTIVITY DATA

This material is a stable alkaline solid at room temperature. It does not undergo hazardous polymerization.

It is incompatible with acidic materials.

SECTION VI. HEALTH HAZARD INFORMATION

TLV None established (See Sect II)

This alkaline material will cause irritation to the respiratory tract if inhaled as a dust or as a solution mist. Prolonged or repeated skin contact will irritate the skin. Eye contact will irritate and can damage the eyes (alkaline attack). This material is low in toxicity by ingestion, but its alkaline nature will irritate, injure the digestive tract. (Trisodium phosphate is used as a food additive; but it must be reduced in alkalinity before being taken into the body.)

FIRST AID:

Eye contact: Promptly flush with plenty of water for 15 minutes. Get medical help.

Skin contact: Wash well with soap and water; rinse well with water. If irritation persists, get medical help.

Inhalation: Remove to fresh air. Get medical help if irritation persists.

Ingestion: Give 1-2 glasses of water or milk to drink to dilute; then give fruit juice or diluted vinegar to drink. Do not induce vomiting! Immediately contact a physician.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

For large spills, notify safety personnel. Clean-up personnel should use protection against contact or inhalation of dust or mist. Scoop up spill for recovery or disposal and place in a container with a lid. Flush residues to the sewer with plenty of water.

DISPOSAL: Scrap material can be used for neutralizing acidic wastes, or it can be buried in an approved manner in an approved landfill. Small amounts can be flushed to the sewer if regulations permit. Follow Federal, State and local regulations for disposal.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general ventilation to the workplace; if dusting conditions occur, local exhaust ventilation will be needed and a NIOSH approved dust respirator may be required.

The use of rubber or plastic gloves and chemical safety glasses with side shields is recommended for handling this material. An apron may also be desirable to prevent contact with clothing, especially where solutions are involved.

Provide eyewash station near to the workplace where this material is used; a safety shower may also be needed where large amounts of solution are prepared or used.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store this material in tightly sealed containers in a clean, dry, ventilated area. Prevent physical damage to containers.

Avoid contact with the body and inhalation of dust.

Note that anhydrous trisodium phosphate and lower hydrates are more alkaline on a weight basis than $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$.

DATA SOURCE(S) CODE: 1.2.4-7.12.15

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, General Electric Company extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

APPROVALS: MIS, CRD

Industrial Hygiene and Safety

Corporate Medical Staff

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard,
29 CFR 1910.1200. Standard must be
consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072



IDENTITY (As Used on Label and List)

LIQUI-NOX

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name

ALCONOX, INC.

Emergency Telephone Number
(212) 473-1300

Telephone Number for Information
(212) 473-1300

Address (Number, Street, City, State, and ZIP Code)

215 PARK AVENUE SOUTH

Date Prepared

JANUARY 5, 1987

NEW YORK, NEW YORK 10003

Signature of Preparer (optional)

Section II — Hazardous Ingredients/Identify Information

Hazardous Components (Specific Chemical Identity; Common Name(s))

OSHA PEL

ACGIH TLV

Other Limits
Recommended

% (optional)

THERE ARE NO INGREDIENTS IN LIQUI-NOX WHICH APPEARED ON THE OSHA STANDARD
29 CFR 1910 SUBPART Z. ALL OF THE INGREDIENTS IN LIQUI-NOX ARE CONSIDERED
TO BE PROPRIETARY INFORMATION AND WE SHALL EXERCISE THE RIGHT TO CONFIDEN-
TIALITY AFFORDED US UNDER THE FEDERAL LAW.

Section III — Physical/Chemical Characteristics

Boiling Point

214°F

Specific Gravity (H₂O = 1)

1.075

Vapor Pressure (mm Hg.)

NO DATA

Melting Point

N.A.

Vapor Density (AIR = 1)

NO DATA

Evaporation Rate
(Butyl Acetate = 1)

SLOWER

Solubility in Water

COMPLETELY SOLUBLE IN ALL PROPORTIONS

Appearance and Odor

YELLOW LIQUID - PRACTICALLY ODORLESS

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)

NONE (CLEVELAND OPEN CUP)

Flammable Limits

LEL
N.A.

UEL
N.A.

Extinguishing Media

WATER, DRY CHEMICAL, FOAM, CO₂, SAND/EARTH

Special Fire Fighting Procedures

FOR FIRES INVOLVING THIS MATERIAL, DO NOT ENTER WITHOUT PROTECTIVE
EQUIPMENT AND SELF CONTAINED BREATHING APPARATUS.

Unusual Fire and Explosion Hazards

NONE

(Reproduce locally)

AR000843

OSHA 174, Sept. 19

Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid	NONE
	Stable	XX		

Incompatibility (Materials to Avoid) NONE

Hazardous Decomposition or Byproducts SO₂, MAY BE RELEASED ON BURNING

Hazardous Polymerization	May Occur		Conditions to Avoid	NONE
	Will Not Occur	XX		

Section VI — Health Hazard Data

Route(s) of Entry:	Inhalation?	NO	Skin?	YES	Ingestion?	YES
--------------------	-------------	----	-------	-----	------------	-----

Health Hazards (Acute and Chronic)
 SKIN CONTACT MAY PROVE LOCALLY IRRITATING INGESTION MAY CAUSE DISCOMFORT AND/OR DIARRHEA.

Carcinogenicity:	NTP?	NO	IARC Monographs?	NO	OSHA Regulated?	NO
------------------	------	----	------------------	----	-----------------	----

Signs and Symptoms of Exposure
 PROLONGED SKIN CONTACT MAY CAUSE DRYING AND/OR CHAPPING

Medical Conditions
 Generally Aggravated by Exposure NONE

Emergency and First Aid Procedures
 EYES - FLUSH WITH PLENTY OF WATER FOR 15 MINUTES SKIN-FLUSH WITH WATER
 INGESTION - DRINK LARGE QUANTITIES OF WATER. GET MEDICAL ATTENTION FOR

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material is Released or Spilled
 MATERIAL FOAMS PROFUSELY. RECOVER AS MUCH AS POSSIBLE WITH ABSORBENT MATERIAL AND RINSE REMAINDER TO SEWER. MATERIAL IS COMPLETELY BIODEGRADABLE

Waste Disposal Method
 SMALL QUANTITIES MAY BE DISPOSED OF IN SEWER. LARGE QUANTITIES SHOULD BE SOAKED UP WITH ABSORBENT MATERIAL AND DISPOSED OF ACCORDING TO LOCAL ORDINANCES

Precautions to Be Taken in Handling and Storing
 NON REQUIRED - VISCOSITY OF MATERIAL INCREASES AT VERY LOW TEMPERATURE.

Other Precautions
 NO SPECIAL REQUIREMENTS OTHER THAN THE GOOD INDUSTRIAL HYGIENE AND SAFE PRACTICES EMPLOYED WITH ANY INDUSTRIAL CHEMICAL.

Section VIII — Control Measures

Respiratory Protection (Specify Type)

Ventilation	Local Exhaust	NORMAL	Special	N.A.
	Mechanical (General)	N.A.	Other	N.A.
Protective Gloves	RECOMMENDED	Eye Protection	RECOMMENDED	

Other Protective Clothing or Equipment NOT REQUIRED

Work/Hygienic Practices NO SPECIAL PRACTICES REQUIRED.

MINERAL SAFETY DATA SHEET

(Essentially Similar to Form OSHA-202)

MSA P/N 34337

SECTION I

PRODUCT NAME	MSA CLEANER-SANITIZER II		
MANUFACTURER	Mine Safety Appliances Company 600 Penn Center Boulevard Pittsburgh, PA 15235	FORMULA CODE	8599-03
		COMPLETED BY	L. P. Dewosky
EMERGENCY PHONE NO.	412-273-5500	TITLE	Mgr. Product Safety
		DATE	6/9/83

SECTION II - INGREDIENTS

	CAS NUMBER	WEIGHT.
ACTIVE INGREDIENTS:		54.7
SODIUM CARBONATE	497-19-8	42.2
TRISODIUM PHOSPHATE	7601-54-9	10.0
ALKYL (C14, 50%; C12, 40%; C16, 10%)		
DIMETHYL BENZYL AMMONIUM CHLORIDES	139-08-2	2.5
INERT INGREDIENTS:		45.3
SODIUM TRIPOLYPHOSPHATE	7758-29-4	
SODIUM BICARBONATE	144-55-8	
WATER	7732-18-5	
ISOMERIC LINEAR ALCOHOLS (C11-C15)		
POLYETHOXY ETANOLS	68131-40-8*	
ETANOL	64-17-5	
ISOBORNYL ACETATE	125-12-2	

SECTION III - PHYSICAL DATA

BOILING POINT (° F.)	NA	SPECIFIC GRAVITY (H ₂ O = 1)	0.8
VAPOR PRESSURE (mm Hg.)	NA	%VOLATILE BY VOLUME	NA
VAPOR DENSITY (AIR = 1)	NA	EVAPORATION RATE (_____ = 1)	NA
SOLUBILITY IN WATER	20%	PH 1% AQUEOUS SOLUTION	9.5 - 10.5
APPEARANCE AND ODOR	FRAGRANT BLEND OF WHITE POWDERS		

SECTION IV - FIRE AND EXPLOSION DATA

FLASH POINT (Method used)	NO FLASH TO 240 F	FLAMMABLE LIMITS	Let NA	Uel NA
EXTINGUISHING MEDIA	WATER SPRAY (FOG), FOAM, DRY CHEMICAL, CARBON DIOXIDE			
SPECIAL FIRE FIGHTING PROCEDURES	BLANKET FIRE WITH EXTINGUISHING MEDIUM			
UNUSUAL FIRE AND EXPLOSION DATA	PRODUCT IS NONREACTIVE AND DOES NOT READILY SUPPORT			

AR000845

- SKIN CONTACT WITH POWDER MAY CAUSE BURNS. FLUSH AFFECTED AREA WITH CLEAN WATER.

EYE CONTACT WITH POWDER MAY CAUSE CORNEAL BURNS. AVOID RUBBING EYES BECAUSE WATER INSOLUBLE PARTICLES MAY SCRATCH CORNEA. IMMEDIATELY FLUSH EYES WITH CLEAN WATER WHILE HOLDING EYELIDS APART. CONTINUE FLUSHING FOR AT LEAST 15 MINUTES OR UNTIL IRRITATION SUBSIDES. CONSULT PHYSICIAN AS SOON AS POSSIBLE.

INHALATION OF A LARGE ENOUGH QUANTITY TO POSE A SIGNIFICANT HEALTH HAZARD IS IMPROBABLE.

INGESTION OF POWDER IS HARMFUL OR FATAL. SHOULD INGESTION OCCUR, DRINK MILK, RAW EGG WHITE, OR GELATIN SOLUTION, OR LARGE QUANTITIES OF WATER. AVOID ALCOHOL. CONSULT PHYSICIAN AS SOON AS POSSIBLE.

SECTION VI - REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID	NONE
	STABLE	X		
HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID	NONE
	WILL NOT OCCUR	X		
HAZARDOUS DECOMPOSITION PRODUCTS	UNDETERMINED			
INCOMPATIBILITY (MATERIALS TO AVOID)	OXIDIZING AGENTS SOAP AND ANIONIC SURFACTANTS DEACTIVATE GERMICIDE			

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED	SWEEP UP
WASTE DISPOSAL METHOD	REMOVE TO SANITARY LANDFILL AWAY FROM WATER SUPPLIES DESTROY EMPTY CONTAINERS

SECTION VIII - SPECIAL PROTECTION INFORMATION

SPECIAL RESPIRATORY PROTECTION	NOT REQUIRED
SPECIAL SKIN PROTECTION	NOT REQUIRED
SPECIAL EYE PROTECTION	NOT REQUIRED

SECTION IX - SPECIAL PRECAUTIONS

SPECIAL HANDLING PRECAUTIONS	NOT REQUIRED
SPECIAL STORAGE PRECAUTIONS	NOT REQUIRED.
OTHER SPECIAL PRECAUTIONS	NOT REQUIRED

AR000846

Mallinckrodt Material Safety Data

Emergency Phone Number: 314-982-5000

NITRIC ACID, 70%

PRODUCT IDENTIFICATION:

Synonyms: Aqua Fortis; Azotic Acid; Nitric Acid 70%

Formula CAS No.: 7697-37-2

Molecular Weight: 63.00

Chemical Formula: HNO_3

Hazardous Ingredients: Not Applicable

PRECAUTIONARY MEASURES

DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED. INHALATION MAY CAUSE LUNG DAMAGE.

Do not get in eyes, on skin, or on clothing. Avoid breathing mist.

Use only with adequate ventilation.

Wash thoroughly after handling.

Keep from contact with clothing and other combustible materials.

Do not store near combustible materials.

Store in a tightly closed container.

Remove and wash contaminated clothing promptly.

This substance is classified as a POISON under the Federal Caustic

Poison Act.

EMERGENCY/FIRST AID

In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes. If swallowed, DO NOT INDUCE VOMITING! Give large quantities of water or milk if available.

Never give anything by mouth to an unconscious person. If inhaled,

remove to fresh air. If not breathing, give artificial

respiration. If breathing is difficult, give oxygen. In all cases

call a physician.

SEE SECTION 5.

DOT Hazard Class: Oxidizer

Effective Date: 10-21-86 Supersedes 09-04-85

SECTION 1 Physical Data

Appearance: Clear, colorless to slightly yellow liquid.

Odor: Suffocating acid.

Solubility: Infinite in water.

Boiling Point: 122°C (252°F)

Melting Point: -34°C (-29°F)

Specific Gravity: 1.41

Vapor Density (Air=1): 2-3 approximately

Vapor Pressure (mm Hg): 62 @ 20°C (68°F)

Evaporation Rate: No information found.

SECTION 2 Fire and Explosion Information

Fire:

Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition. Can react with metals to release flammable hydrogen gas.

Explosion:

Reacts explosively with combustible organic or readily oxidizable materials such as: alcohols, turpentine, charcoal, organic refuse, metal powder, hydrogen sulfide, etc.

Fire Extinguishing Media:

If involved in a fire, use water spray.

Special Information:

Increases the flammability of combustible, organic and readily oxidizable materials. In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full face-piece operated in the pressure demand or other positive pressure mode.

SECTION 3 Reactivity Data

Stability:

Stable under ordinary conditions of use and storage. Containers may burst when heated.

Hazardous Decomposition Products:

When heated to decomposition, emits toxic nitrogen oxides fumes and hydrogen nitrate. Will react with water or steam to produce heat and toxic and corrosive fumes.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

A dangerously powerful oxidizing agent, concentrated nitric acid is incompatible with most substances, especially strong bases, metallic powders, carbides, hydrogen sulfide, turpentine, and combustible organics.

SECTION 4 Leak/Spill Disposal Information

Isolate or enclose the area of the leak or spill. Clean-up personnel should wear protective clothing and respiratory equipment suitable for toxic or corrosive fluids or vapors.

Small Spills: Flush with water and neutralize with alkaline material (soda ash, lime, etc.). Sewer with excess water.

Larger spills and lot sizes: Neutralize with alkaline material, pick up with absorbent material (sand, earth, vermiculite) and dispose in a RCRA-approved waste facility or sewer the neutralized slurry with excess water if local ordinances allow. Provide forced ventilation to dissipate fumes.

Reportable Quantity (RQ)(CWA/CERCLA): 1000 lbs.

Ensure compliance with local, state and federal regulations.

NEPA Ratings: Health: 3 Flammability: 0 Reactivity: 0 Other: Oxidizer

NITRIC ACID, 70%

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SECTION 5 Health Hazard Information

A. EXPOSURE / HEALTH EFFECTS

Inhalation:

Corrosive Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract.

Ingestion:

Corrosive Swallowing nitric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract.

Skin Contact:

Corrosive Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color.

Eye Contact:

Corrosive Vapors are irritating and may cause damage to the eyes. Splashes may cause severe burns and permanent eye damage.

Chronic Exposure:

Long-term exposure to concentrated vapors may cause erosion of teeth. Long term exposures seldom occur due to the corrosive properties of the acid.

Aggravation of Pre-existing Conditions:

Persons with pre-existing skin disorders or eye disease may be more susceptible to the effects of this substance.

B. FIRST AID

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Ingestion:

DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Exposure:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Eye Exposure:

Wash eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

C. TOXICITY DATA (RTECS, 1982)

Inhalation (Rat) LC50: 244 ppm (NO₂)/30M

SECTION 6 Occupational Control Measures

Airborne Exposure Limits:

-OSHA Permissible Exposure Limit (PEL):

2 ppm (TWA)

-ACGIH Threshold Limit Value (TLV):

2 ppm (TWA); 4ppm (STEL)

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, "Industrial Ventilation, A Manual of Recommended Practices", most recent edition, for details.

Personal Respirators: (NIOSH Approved)

If the TLV is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or self-contained breathing apparatus. Nitric acid is an oxidizer and should not come in contact with cartridges and canisters that contain oxidizable materials, such as activated charcoal.

Skin Protection:

Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or a full face shield where splashing is possible. Contact lenses should not be worn when working with this material. Maintain eye wash fountain and quick-drench facilities in work area.

SECTION 7 Storage and Special Information

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect from physical damage and direct sunlight. Isolate from incompatible substances. Protect from moisture.

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Mallinckrodt

Material Safety Data

Emergency Phone Number: 314-982-5000

HYDROCHLORIC ACID, 37%

PRODUCT IDENTIFICATION:

Synonyms: Muriatic acid

Formula CAS No.: 7647-01-0

Molecular Weight: 36.46 (HCl)

Chemical Formula: HCl

Hazardous Ingredients: Not Applicable

PRECAUTIONARY MEASURES

DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED. INHALATION MAY CAUSE LUNG DAMAGE.

Do not get in eyes, on skin, or on clothing.
Avoid breathing mist.

Use only with adequate ventilation.

Wash thoroughly after handling.

Store in a tightly closed container.

Remove and wash contaminated clothing promptly.

This substance is classified as a POISON under the Federal Caustic Poison Act.

EMERGENCY/FIRST AID

In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes. If swallowed, DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. **NEVER** give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases call a physician.
SEE SECTION 5.

DOT Hazard Class: Corrosive Material

AR0000849

Effective Date: 09-10-86 Supersedes 08-21-85

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SECTION 1 Physical Data

Appearance: Clear, colorless fuming liquid.

Odor: Pungent odor of hydrogen chloride.

Solubility: Infinite in water with slight evolution of heat.

Boiling Point: 53°C (127°F); Azeotrope (20.2%) boils at 109°C (228°F)

Melting Point: -74°C (-101°F)

Specific Gravity: 1.18

Vapor Density (Air=1): No information found.

Vapor Pressure (mm Hg): 190 @ 25°C (77°F)

Evaporation Rate: No information found.

SECTION 2 Fire and Explosion Information

Fire:

Can react with metals to release flammable hydrogen gas.

Explosion:

Not considered to be an explosion hazard.

Fire Extinguishing Media:

If involved in a fire, use water spray.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

SECTION 3 Reactivity Data

Stability:

Stable under ordinary conditions of use and storage. Containers may burst when heated.

Hazardous Decomposition Products:

When heated to decomposition, emits toxic hydrogen chloride fumes and will react with water or steam to produce heat and toxic and corrosive fumes.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

A strong mineral acid, concentrated hydrochloric acid is highly reactive with strong bases, metals, metal oxides, hydrosulfides, amines, carbonates and other alkaline materials. Incompatible with materials such as cyanides, sulfides, sulfites, and formaldehyde.

SECTION 4 Leak/Spill Disposal Information

Clean-up personnel should wear protective clothing and respiratory equipment suitable for toxic or corrosive fluids or vapors. Isolate or enclose the area of the leak or spill.

Small Spills: Flush with water and neutralize with alkaline material (soda ash, lime, etc.). Sewer neutralized material with excess water. Larger spills and lot sizes: Neutralize with alkaline material, pick up with absorbent material (sand, earth, vermiculite). Provide forced ventilation to dissipate fumes. Dispose in a RCRA-approved waste facility or sewer the neutralized slurry with excess water if local ordinances allow.

Reportable Quantity (RQ)(CWA/CERCLA) : 5000 lbs.

Ensure compliance with local, state and federal regulations.

Mallinckrodt makes no representations, or warranties, either express or implied, of merchantability, fitness for a particular purpose with respect to the information set forth herein or to the product to which the information refers. Accordingly, Mallinckrodt will not be responsible for damages resulting from use of or reliance upon this information.

Mallinckrodt, Inc., Science Products Division, P.O. Box M, Paris, KY 40361.

HYDROCHLORIC ACID, 37%

NEPA Ratings: Health: 3 Flammability: 0 Reactivity: 0

HYDROCHLORIC ACID, 37%

SECTION 5 Health Hazard InformationA. EXPOSURE / HEALTH EFFECTSInhalation:

Corrosive! Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract. Inhalation of higher concentrations may cause lung damage.

Ingestion:

Corrosive! Swallowing hydrochloric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract. May cause nausea, vomiting, and diarrhea.

Skin Contact:

Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and discolor skin.

Eye Contact:

Corrosive! Vapors are irritating and may cause damage to the eyes. Splashes may cause severe burns and permanent eye damage.

Chronic Exposure:

Long-term exposure to concentrated vapors may cause erosion of teeth. Long term exposures seldom occur due to the corrosive properties of the acid.

Aggravation of Pre-existing Conditions:

Persons with pre-existing skin disorders or eye disease may be more susceptible to the effects of this substance.

B. FIRST AIDInhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Ingestion:

DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Exposure:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Eye Exposure:

Wash eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

C. TOXICITY DATA

(RTECS, 1982)

Oral rat LD50: 900 mg/kg (Hydrochloric acid concentrated) Mutation references cited.

SECTION 6 Occupational Control MeasuresAirborne Exposure Limits:

-OSHA Permissible Exposure Limit (PEL):

5 ppm (TWA) Ceiling

-ACGIH Threshold Limit Value (TLV):

5 ppm (TWA) Ceiling

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, "Industrial Ventilation, A Manual of Recommended Practices", most recent edition, for details.

Personal Respirators: (NIOSH Approved)

If the TLV is exceeded a full facepiece chemical cartridge respirator may be worn, in general, up to 100 times the TLV or the maximum use concentration specified by the respirator supplier, whichever is less. Alternatively, a supplied air full facepiece respirator or airlined hood may be worn.

Skin Protection:

Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or a full face shield where splashing is possible. Contact lenses should not be worn when working with this material. Maintain eye wash fountain and quick-drench facilities in work area.

SECTION 7 Storage and Special Information

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect from physical damage and direct sunlight. Isolate from incompatible substances. Protect from moisture.

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MATERIAL SAFETY DATA SHEET

FISHER SCIENTIFIC
CHEMICAL DIVISION
1 REAGENT LANE
FAIR LAWN NJ 07410
(201) 796-7100

EMERGENCY CONTACTS:
GASTON L. PILLORI
(201) 796-7100

DATE: 02/08/89
PO NBR: 63099
ACCT: 111597-01
INDEX: 03890300010
CAT NO: A298212

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SUBSTANCE IDENTIFICATION

SUBSTANCE: SSSULFURIC ACIDSS

CAS-NUMBER 7664-93-9

TRADE NAMES/SYNONYMS:

OIL OF VITRIOL, BOV, DIPPING ACID, VITRIOL BROWN OIL, HYDROGEN SULFATE, NORDHAUSEN ACID, DIHYDROGEN SULFATE, SULPHURIC ACID, MATTING ACID, DITHIONIC ACID, STC: 4930040, UN 1830, A-300, A-300C, A-300-6I, A-3006, A-298, A-510, A-468, SO-A-172, SO-A-174, ACC22350

CHEMICAL FAMILY:
INORGANIC ACID

MOLECULAR FORMULA: H2-S-O4

MOLECULAR WEIGHT: 98.07

CERCLA RATINGS (SCALE 0-3): HEALTH=3 FIRE=0 REACTIVITY=2 PERSISTENCE=0
NFPA RATINGS (SCALE 0-4): HEALTH=3 FIRE=0 REACTIVITY=2

COMPONENTS AND CONTAMINANTS

COMPONENT: SULFURIC ACID

PERCENT: 98

COMPONENT: WATER

PERCENT: 2

OTHER CONTAMINANTS: NONE

EXPOSURE LIMITS:

SULFURIC ACID:

- 1 MG/M3 OSHA TWA
- 1 MG/M3 ACGIH TWA (NOTICE OF INTENDED CHANGE 1987-1988)
- 1 MG/M3 NIOSH RECOMMENDED 10 HOUR TWA

1000 POUNDS SARA SECTION 302 THRESHOLD PLANNING QUANTITY

1000 POUNDS SARA SECTION 304 REPORTABLE QUANTITY

SUBJECT TO SARA SECTION 313 ANNUAL TOXIC CHEMICAL RELEASE REPORTING

PHYSICAL DATA

DESCRIPTION: ODORLESS, CLEAR, COLORLESS, DENSE HYGROSCOPIC OILY LIQUID WITH A MARKED ACID TASTE WHEN PURE. BOILING POINT: 559 F (290 C)

MELTING POINT: 50 F (10 C) SPECIFIC GRAVITY: 1.84

VAPOR PRESSURE: <0.001 @ 20 C PH: <3 SOLUBILITY IN WATER: SOLUBLE

ODOR THRESHOLD: >1 MG/M3 VAPOR DENSITY: 3.4

SOLVENT SOLUBILITY: DECOMPOSES IN ETHYL ALCOHOL

@ 340 C IT DECOMPOSES INTO SULFUR TRIOXIDE AND WATER

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD:
NEGLECTIBLE FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

OXIDIZER: OXIDIZERS DECOMPOSE, ESPECIALLY WHEN HEATED, TO YIELD OXYGEN OR OTHER GASES WHICH WILL INCREASE THE BURNING RATE OF COMBUSTIBLE MATTER. CONTACT WITH EASILY OXIDIZABLE, ORGANIC, OR OTHER COMBUSTIBLE MATERIALS MAY RESULT IN IGNITION, VIOLENT COMBUSTION OR EXPLOSION.

FIREFIGHTING MEDIA:

DRY CHEMICAL, CARBON DIOXIDE OR HALON
(1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

FOR LARGER FIRES, FLOOD AREA WITH WATER FROM A DISTANCE
(1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

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FIREFIGHTING:
DO NOT GET SOLID STREAM OF WATER ON SPILLED MATERIAL. MOVE CONTAINERS FROM FIRE AREA IF POSSIBLE. COOL CONTAINERS EXPOSED TO FLAMES WITH WATER FROM SIDE UNTIL WELL AFTER FIRE IS OUT. KEEP AWAY FROM STORAGE TANK ENDS (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800, 4 GUIDE PAGE 39).

USE AGENT SUITABLE FOR TYPE OF FIRE, USE FLOODING AMOUNTS OF WATER AS A FOG. COOL CONTAINERS WITH FLOODING AMOUNTS OF WATER, APPLY FROM AS FAR A DISTANCE AS POSSIBLE. AVOID BREATHING CORROSIVE VAPORS, KEEP UPWIND.

TRANSPORTATION DATA

DEPARTMENT OF TRANSPORTATION HAZARD CLASSIFICATION 49CFR172.101:
CORROSIVE MATERIAL

DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS 49CFR172.101 AND 172.402:
CORROSIVE

DEPARTMENT OF TRANSPORTATION PACKAGING REQUIREMENTS: 49CFR173.272
EXCEPTIONS: 49CFR173.244

TOXICITY

SULFURIC ACID:
1380 UG EYE-RABBIT SEVERE IRRITATION, 100 MG EYE-RABBIT RINSED SEVERE IRRITATION, 3 MG/M3/24 WEEKS INHALATION-HUMAN TCLO, 510 MG/M3/2 HOURS INHALATION-RAT LC50, 320 MG/M3 2 HOURS INHALATION-MOUSE LC50, 18 MG/M3 INHALATION-GUINEA PIG LC50, 2140 MG/KG ORAL-RAT LD50, 135 MG/KG UNREPORTED-MAN LDLO, TUMORIGENIC DATA (AJEPAS 120(3), 358, 84).

CARCINOGEN STATUS: NONE.

SULFURIC ACID IS HIGHLY TOXIC, AND A SEVERE EYE, SKIN AND MUCOUS MEMBRANE IRRITANT. POISONING MAY AFFECT THE BODY'S PH BALANCE AND IN TURN AFFECT THE NERVOUS SYSTEM.

HEALTH EFFECTS AND FIRST AID

INHALATION:

SULFURIC ACID:

CORROSIVE/HIGHLY TOXIC. 80 MG/M3 IMMEDIATELY DANGEROUS TO LIFE OR HEALTH.

ACUTE EXPOSURE- INHALATION OF MISTS MAY CAUSE MUCOUS MEMBRANE IRRITATION PRINCIPALLY AFFECTING THE RESPIRATORY TRACT EPITHELIUM. LOW CONCENTRATIONS, 0.35-5 MG/M3, MAY CAUSE INCREASED PULMONARY AIR FLOW RESISTANCE AND SUBSEQUENT SHALLOWER AND MORE RAPID BREATHING. HOT CONCENTRATED MISTS MAY CAUSE RAPID LOSS OF CONSCIOUSNESS WITH POSSIBLE DAMAGE TO LUNG TISSUE. VAPORS MAY CAUSE NASAL SECRETIONS, SNEEZING, A BURNING OR TICKLING SENSATION IN THE NOSE AND THROAT AND RETROSTERNAL REGION, FOLLOWED BY COUGH, RESPIRATORY DISTRESS, TRACHEOBRONCHITIS, CHEMICAL PNEUMONITIS AND POSSIBLE SPASM OF THE VOCAL CORDS. HIGH CONCENTRATIONS MAY PRODUCE BLOODY NASAL SECRETIONS AND SPUTUM, HEMATEMESIS GASTRITIS, AND PULMONARY EDEMA. A SINGLE OVEREXPOSURE MAY LEAD TO LARYNGEAL, TRACHEOBRONCHIAL AND PULMONARY EDEMA. ONE INDIVIDUAL SPRAYED IN THE FACE WITH SULFURIC ACID LIQUID EXPERIENCED DELAYED SYMPTOMS OF PULMONARY FIBROSIS, RESIDUAL BRONCHITIS, AND PULMONARY EMPHYSEMA. VAPORS FROM DILUTE SOLUTIONS MAY IRRITATE MUCOUS MEMBRANES.

CHRONIC EXPOSURE- REPEATED EXPOSURE TO THE MIST MAY CAUSE INFLAMMATION OF THE UPPER RESPIRATORY TRACT, CHRONIC BRONCHITIS AND ETCHING OF THE DENTAL ENAMEL. THE CENTRAL AND LATERAL INCISORS ARE PRIMARILY AFFECTED. REPEATED EXCESSIVE EXPOSURE OVER LONG PERIODS OF TIME HAVE RESULTED IN BRONCHITIC SYMPTOMS, RHINORRHEA, FREQUENT RESPIRATORY TRACT INFECTIONS, EMPHYSEMA, STOMATITIS AND DIGESTIVE DISTURBANCES. CHRONIC INHALATION MAY CAUSE ALKALINE DEPLETION OF THE BODY PRODUCING AN ACIDOSIS WHICH AFFECTS THE NERVOUS SYSTEM AND PRODUCES AGITATION, HESITANT GAIT AND GENERALIZED WEAKNESS. AN EPIDEMIOLOGICAL STUDY OF WORKERS AT A REFINERY AND CHEMICAL PLANT SUGGESTS AN INCREASED RISK OF LARYNGEAL CANCER FROM EXPOSURE TO HIGH CONCENTRATIONS OF SULFURIC ACID.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. MAINTAIN AIRWAY AND BLOOD PRESSURE AND ADMINISTER OXYGEN IF AVAILABLE. KEEP AFFECTED PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. ADMINISTRATION OF OXYGEN SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:

SULFURIC ACID:

CORROSIVE.

ACUTE EXPOSURE- CONTACT WITH CONCENTRATED SULFURIC ACID MAY CAUSE SEVERE SECOND AND THIRD DEGREE SKIN BURNS WITH NECROSIS DUE TO ITS AFFINITY FOR WATER AND SUBSEQUENT SEVERE DEHYDRATING ACTION, AND ITS EXOTHERMIC REACTION WITH MOISTURE. POSSIBLE CHARRING MAY OCCUR LEADING TO SHOCK AND COLLAPSE DEPENDING ON THE AMOUNT OF TISSUE INVOLVED. THE RESULTING WOUNDS MAY BE LONG IN HEALING AND MAY CAUSE EXTENSIVE SCARRING THAT MAY RESULT IN FUNCTIONAL INHIBITION. CONTACT WITH DILUTE SOLUTIONS MAY CAUSE SKIN IRRITATION.

CHRONIC EXPOSURE- REPEATED CONTACT WITH LOW CONCENTRATIONS MAY CAUSE SKIN DESICCATION AND ULCERATION OF THE HANDS, AND PANARIS OR CHRONIC PURULENT INFLAMMATION AROUND THE NAILS. REPEATED CONTACT WITH DILUTE SOLUTIONS MAY CAUSE DERMATITIS.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (AT LEAST 15-20 MINUTES). IN CASE OF CHEMICAL BURNS, COVER AREA WITH STERILE, DRY DRESSING. BANDAGE SECURELY, BUT NOT TOO TIGHTLY. GET MEDICAL ATTENTION IMMEDIATELY.

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**EYE CONTACT:
SULFURIC ACID:
CORROSIVE.**

ACUTE EXPOSURE- EXPOSURE TO THE VAPORS MAY CAUSE A BURNING OR STINGING SENSATION IN THE EYES WITH LACRIMATION, BLURRED VISION AND CONJUNCTIVAL CONGESTION. SPLASHES OF ACID IN THE EYES MAY PRODUCE DEEP CORNEAL ULCERATION, KERATO-CONJUNCTIVITIS AND PALPEBRAL LESIONS WITH SEVERE SEQUELAE. IRREPARABLE CORNEAL DAMAGE AND BLINDNESS AS WELL AS SCARRING OF THE EYELIDS MAY OCCUR. SEVERE SULFURIC ACID EYE BURNS HAVE INCLUDED GLAUCOMA AND CATARACT AS COMPLICATIONS IN THE MOST SEVERE CASES. CONTACT WITH DILUTED ACID MAY PRODUCE MORE TRANSIENT EFFECTS FROM WHICH RECOVERY MAY BE COMPLETE.

CHRONIC EXPOSURE- REPEATED EXPOSURE MAY RESULT IN LACRIMATION AND CHRONIC CONJUNCTIVITIS.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER. OCCASIONALLY LIFTING UPPER AND LOWER LIDS. UNTIL NO EVIDENCE OF CHEMICAL REMAINS (AT LEAST 15-20 MINUTES). CONTINUE IRRIGATING WITH NORMAL SALINE UNTIL THE PH HAS RETURNED TO NORMAL (30-60 MINUTES). COVER WITH STERILE BANDAGES. GET MEDICAL ATTENTION IMMEDIATELY.

**INGESTION:
SULFURIC ACID:
CORROSIVE.**

ACUTE EXPOSURE- INGESTION MAY CAUSE BURNING PAIN IN THE MOUTH, THROAT, ESOPHAGUS AND ABDOMEN, A SOUR TASTE AND NAUSEA FOLLOWED BY VOMITING AND DIARRHEA OF CHARRED BLACK STOMACH CONTENTS. DEHYDRATION AND CARBONIZATION OF TISSUE MAY OCCUR WITH ESCHARS ON THE LIPS AND MOUTH. BROWNISH OR YELLOWISH STAINS MAY BE FOUND AROUND THE MOUTH, INTENSE THIRST, DIFFICULT SWALLOWING, ACIDEMIA, STOMATITIS, RAPID AND WEAK PULSE, SHALLOW BREATHING, SHOCK AND POSSIBLE CONVULSIONS MAY OCCUR. ALBUMIN, BLOOD AND CASTS IN URINE, ANURIA, ESOPHAGEAL AND DELAYED GASTRIC STENOSIS HAS BEEN REPORTED. POSSIBLE PERFORATION OF THE GASTROINTESTINAL TRACT MAY RESULT IN PERITONITIS.

CHRONIC EXPOSURE- NO DATA AVAILABLE.

FIRST AID- IF VICTIM IS CONSCIOUS, GIVE HIM LARGE QUANTITIES OF WATER IMMEDIATELY TO DILUTE THE ACID. DO NOT INDUCE VOMITING. GIVE PATIENT 1 OUNCE (30 ML) OF MILK OF MAGNESIA. GET MEDICAL ATTENTION IMMEDIATELY.

ANTIDOTE:
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY

REACTIVITY:
VIOLENT EXOTHERMIC REACTION WITH WATER.

**INCOMPATIBILITIES:
SULFURIC ACID:**

ACETALDEHYDE: VIOLENTLY POLYMERIZED BY CONCENTRATED ACID.
ACETIC ANHYDRIDE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
ACETONE + NITRIC ACID: VIOLENT DECOMPOSITION.
ACETONE + POTASSIUM DICHROMATE: IGNITION.
ACETONE CYANHYDRIN: PRESSURE INCREASE WITH POSSIBLE EXPLOSIVE RUPTURE OF VESSEL.
ACETONITRILE: VIOLENT EXOTHERM ON HEATING; SULFUR TRIOXIDE REDUCES INITIATION TEMPERATURE.
ACROLEIN: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
ACRYLONITRILE: VIGOROUS EXOTHERMIC POLYMERIZATION.
ALCOHOL: EXOTHERMIC REACTION AND CONTRACTION OF VOLUME.
ALCOHOLS AND HYDROGEN PEROXIDE: POSSIBLE EXPLOSION.
ALLYL ALCOHOL: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
ALLYL CHLORIDE: VIOLENT POLYMERIZATION.
ALKYL NITRATES: MAY CAUSE VIOLENT REACTION.
2-AMINOETHANOL: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
AMMONIUM HYDROXIDE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
AMMONIUM IRON(III) SULFATE DODECAHYDRATE: VIOLENT, EXOTHERMIC REACTION ON HEATING.
AMMONIUM TRIPERCHROMATE: FIRE OR EXPLOSION HAZARD.
ANILINE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
BASES: VIOLENT REACTION.
BENZYL ALCOHOL: MAY DECOMPOSES EXPLOSIVELY AT ABOUT 180 C.
BROMATES + METALS: POSSIBLE IGNITION.
BROMINE PENTAFLUORIDE: VIOLENT REACTION WITH POSSIBLE IGNITION.
TERT-BUTYL-M-XYLENE: VIOLENT EXOTHERMIC REACTION WITHOUT AGITATION.
N-BUTYRALDEHYDE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
CARBIDES: HAZARDOUS MIXTURE.
CESIUM ACETYLIDE: IGNITION ON CONTACT.
4-CHLORONITROBENZENE AND SULFUR TRIOXIDE: POSSIBLE EXPLOSIVE REACTION.
CHLORATES: ALL CHLORATES, WHEN BROUGHT IN CONTACT WITH SULFURIC ACID MAY GIVE OFF EXPLOSIVE CHLORINE DIOXIDE GAS. A VIOLENT EXPLOSION IS USUAL.
CHLORATES + METALS: POSSIBLE IGNITION.
CHLORINE TRIFLUORIDE: VIOLENT REACTION.
CHLOROSULFONIC ACID: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
CHROMATES: FIRE AND EXPLOSION HAZARD.
COATINGS: ATTACKED.
COMBUSTIBLE MATERIALS (FINELY DIVIDED): MAY IGNITE.
COPPER: EVOLUTION OF SULFUR DIOXIDE.
CUPROUS NITRIDE: VIOLENT REACTION.
2-CYANO-4-NITROBENZENEDIAZONIUM HYDROGEN SULFATE: EXOTHERMIC REACTION.
2-CYANO-2-PROPANOL: VIOLENT REACTION WITH INCREASE IN PRESSURE.
CYCLOPENTADIENE: VIOLENT OR EXPLOSIVE REACTION.
CYCLOPENTANONE OXIME: VIOLENT REACTION.
1,3-DIAZIDOBENZENE: IGNITION FOLLOWED BY EXPLOSIVE REACTION.
DIETHYLAMINE: EXOTHERMIC REACTION.

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DIISOBUTYLENE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 DIMETHYLBENZYLCABINOL + HYDROGEN PEROXIDE: EXPLODES.
 DIMETHOXYANTHRAQUINONE: EXOTHERMIC REACTION ABOVE 150 C.
 2,5-DINITRO-3-METHYLBENZOIC ACID + SODIUM AZIDE: EXPLOSIVE REACTION.
 1,5-DINITRONAPHTHALENE + SULFUR: EXOTHERMIC REACTION.
 EPICHLOROHYDRIN: VIOLENT REACTION.
 ETHOXYLATED NONYLPHENOL: POSSIBLE IGNITION.
 ETHANOL + HYDROGEN PEROXIDE: POSSIBLE EXPLOSION.
 ETHYLENE CYANOHYDRIN: VIOLENT REACTION.
 ETHYLENE DIAMINE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 ETHYLENE GLYCOL: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 ETHYLENIMINE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 FULMINATES: EXTREMELY HAZARDOUS MIXTURE.
 HEXALITHIUM DISILICIDE: INCANDESCENT REACTION.
 HYDROCHLORIC ACID: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 HYDROGEN PEROXIDE (>50%): EXPLOSIVE REACTION AFTER EVAPORATION.
 HYDROFLUORIC ACID: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 INDANE + NITRIC ACID: POSSIBLE EXPLOSION.
 IODINE HEPTAFLUORIDE: THE ACID BECOMES EFFERVESCENT.
 IRON: POSSIBLE EXPLOSION DUE TO HYDROGEN GAS FROM THE ACID-METAL REACTION.
 ISOPRENE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 LITHIUM SILICIDE: INCANDESCENT REACTION.
 MERCURY NITRIDE: EXPLOSION ON CONTACT.
 MESITYL OXIDE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 METALS: MAY LIBERATE FLAMMABLE HYDROGEN GAS.
 METALS (POWDERED): EXTREMELY HAZARDOUS MIXTURE.
 METAL ACETYLIDES: IGNITION REACTION.
 METAL CHLORATES: VIOLENT EXPLOSION UNLESS PROPERLY COOLED.
 METAL PERCHLORATES: FORMATION OF EXPLOSIVE PERCHLORIC ACID.
 4-METHYLPYRIDINE: EXOTHERMIC REACTION.
 NITRAMIDE: MAY DECOMPOSE EXPLOSIVELY ON CONTACT.
 NITRATES: INCOMPATIBLE.
 NITRIC ACID + GLYCERIDES: EXPLOSION.
 NITRIC ACID + ORGANIC MATERIAL: MAY CAUSE VIOLENT REACTION.
 NITRIC ACID + TOLUENE: POSSIBLE VIOLENT REACTION OR EXPLOSION.
 NITROARYL BASES AND DERIVATIVES: MAY CAUSE VIOLENT REACTION OR EXPLOSION.
 NITROBENZENE: EXOTHERMIC REACTION AT ELEVATED TEMPERATURES.
 3-NITROBENZENESULFONIC ACID: EXOTHERMIC REACTION.
 NITROMETHANE: FORMATION OF EXPLOSIVE MIXTURE.
 N-NITROMETHYLAMINE: EXPLOSIVE DECOMPOSITION.
 4-NITROTOLUENE: EXPLOSIVE AT 80 C.
 ORGANICS: VIOLENT EXOTHERMIC REACTION.
 PENTASILVER TRIHYDROXYDIAMINOPHOSPHATE: EXPLOSION ON CONTACT.
 PERCHLORATES: POSSIBLE EXPLOSION.
 PERCHLORIC ACID: FORMATION OF DANGEROUS ANHYDROUS PERCHLORIC ACID.
 PERMANGANATES: FORMATION OF PERMANGANIC ACID.
 PERMANGANATES + BENZENE: POSSIBLE EXPLOSION.
 1-PHENYL-2-METHYL-PROPYL ALCOHOL + HYDROGEN PEROXIDE: POSSIBLE EXPLOSION.
 PHOSPHORUS (WHITE OR YELLOW): IGNITION IN CONTACT WITH BOILING ACID.
 PHOSPHORUS ISOCYANATE: VIOLENT REACTION.
 PHOSPHORUS TRIOXIDE: VIOLENT OXIDATION WITH POSSIBLE IGNITION.
 PICRATES: EXTREMELY HAZARDOUS MIXTURE.
 PLASTICS: ATTACKED.
 POLYSILOYLENE: EXPLOSION ON CONTACT.
 POTASSIUM: EXPLOSIVE INTERACTION.
 POTASSIUM TERT-BUTOXIDE: IGNITION.
 POTASSIUM CHLORATE: POSSIBLE FIRE AND EXPLOSION.
 POTASSIUM PERMANGANATE: POSSIBLE EXPLOSION IN THE PRESENCE OF MOISTURE.
 POTASSIUM PERMANGANATE + POTASSIUM CHLORIDE: VIOLENT EXPLOSION.
 PROPIOLACTONE (BETA): TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 PROPYLENE OXIDE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 3-PROPYNOL: POSSIBLE EXPLOSION UNLESS ADEQUATELY COOLED.
 PYRIDINE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 REDUCING AGENTS: REACTS.
 RUBBER: ATTACKED.
 RUBIDIUM ACETYLIDE: IGNITION ON CONTACT.
 SILVER PERMANGANATE (MOIST): EXPLOSIVE REACTION.
 SILVER PEROXOCHROMATE: EXPLOSIVE REACTION.
 SODIUM: EXPLOSIVE REACTION WITH AQUEOUS ACID.
 SODIUM CARBONATE: VIOLENT REACTION.
 SODIUM CHLORATE: POSSIBLE FIRE OR EXPLOSION.
 SODIUM HYDROXIDE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 SODIUM TETRAHYDROBORATE: VIOLENT, EXOTHERMIC REACTION.
 SODIUM THIOCYANATE: VIOLENT EXOTHERMIC WITH EVOLUTION OF CARBONYL SULFIDE.
 STEEL: POSSIBLE EXPLOSION DUE TO HYDROGEN GAS FROM THE ACID-METAL REACTION.
 STYRENE MONOMER: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 TETRAMETHYLBENZENES: VIOLENT REACTION IN CLOSED CONTAINERS.
 1,2,4,5-TETRAZINE: VIOLENT DECOMPOSITION ON CONTACT.
 THALLIUM(I) AZIDIDITHIOCARBONATE: MAY EXPLODE ON CONTACT.
 1,3,5-TRINITROSOHEXAHYDRO-1,3,5-TRIAZINE: EXPLOSIVE DECOMPOSITION ON CONTACT.
 VINYL ACETATE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
 ZINC CHLORATE: LIKELY TO CAUSE FIRES AND EXPLOSIONS.
 ZINC IODIDE: VIOLENT INTERACTION.

DECOMPOSITION:
 THERMAL DECOMPOSITION MAY RELEASE TOXIC OXIDES OF SULFUR.

POLYMERIZATION:
 HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

 STORAGE AND DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

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STORAGE

PROTECT AGAINST PHYSICAL DAMAGE AND WATER. SEPARATE FROM CARBIDES, CHLORATES, FULMINATES, NITRATES, PICRATES, POWDERED METALS, AND COMBUSTIBLE MATERIALS (NFPA 49, HAZARDOUS CHEMICALS DATA, 1975).

STORE AWAY FROM INCOMPATIBLE SUBSTANCES.

THRESHOLD PLANNING QUANTITY (TPQ):
THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) SECTION 302 REQUIRES THAT EACH FACILITY WHERE ANY EXTREMELY HAZARDOUS SUBSTANCE IS PRESENT IN A QUANTITY EQUAL TO OR GREATER THAN THE TPQ ESTABLISHED FOR THAT SUBSTANCE NOTIFY THE STATE EMERGENCY RESPONSE COMMISSION FOR THE STATE IN WHICH IT IS LOCATED. SECTION 303 OF SARA REQUIRES THESE FACILITIES TO PARTICIPATE IN LOCAL EMERGENCY RESPONSE PLANNING (40 CFR 355.30).

DISPOSAL

DISPOSAL MUST BE IN ACCORDANCE WITH STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE. 40 CFR 262. EPA HAZARDOUS WASTE NUMBER D002.

CONDITIONS TO AVOID

MAY IGNITE OTHER COMBUSTIBLE MATERIALS (WOOD, PAPER, OIL, ETC.). VIOLENT REACTION WITH WATER. FLAMMABLE, POISONOUS GASES MAY ACCUMULATE IN CONFINED SPACES. RUNOFF TO SEWER MAY CREATE FIRE OR EXPLOSION HAZARD.

SPILL AND LEAK PROCEDURES

SOIL SPILL:
DIG HOLDING AREA SUCH AS LAGOON, POND OR PIT FOR CONTAINMENT.

DIKE FLOW OF SPILLED MATERIAL USING SOIL OR SANDBAGS OR FOAMED BARRIERS SUCH AS POLYURETHANE OR CONCRETE.

USE CEMENT POWDER OR FLY ASH TO ABSORB LIQUID MASS.

NEUTRALIZE SPILL WITH SLAKED LIME, SODIUM BICARBONATE OR CRUSHED LIMESTONE.

AIR SPILL:
APPLY WATER SPRAY TO KNOCK DOWN AND REDUCE VAPORS. KNOCK-DOWN WATER IS CORROSIVE AND TOXIC AND SHOULD BE DIKED FOR CONTAINMENT AND LATER DISPOSAL.

WATER SPILL:
NEUTRALIZE WITH AGRICULTURAL LIME, SLAKED LIME, CRUSHED LIMESTONE, OR SODIUM BICARBONATE.

OCCUPATIONAL SPILL:
KEEP COMBUSTIBLES (WOOD, PAPER, OIL, ETC.) AWAY FROM SPILLED MATERIAL. DO NOT TOUCH SPILLED MATERIAL. DO NOT GET WATER INSIDE CONTAINER. STOP LEAK IF YOU CAN DO IT WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. DO NOT PUT WATER ON LEAK OR SPILL AREA. CLEAN UP ONLY UNDER THE SUPERVISION OF AN EXPERT. DIKE SPILL FOR LATER DISPOSAL. DO NOT APPLY WATER UNLESS DIRECTED TO DO SO. KEEP UNNECESSARY PEOPLE AWAY. ISOLATE HAZARD AREA AND DENY ENTRY. VENTILATE CLOSED SPACES BEFORE ENTERING.

REPORTABLE QUANTITY (RQ): 1000 POUNDS
THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) SECTION 304 REQUIRES THAT A RELEASE EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY FOR THIS SUBSTANCE BE IMMEDIATELY REPORTED TO THE LOCAL EMERGENCY PLANNING COMMITTEE AND THE STATE EMERGENCY RESPONSE COMMISSION (40 CFR 355.40). IF THE RELEASE OF THIS SUBSTANCE IS REPORTABLE UNDER CERCLA SECTION 103, THE NATIONAL RESPONSE CENTER MUST BE NOTIFIED IMMEDIATELY AT (800) 424-8802 OR (202) 426-2675 IN THE METROPOLITAN WASHINGTON, D.C. AREA (40 CFR 302.6).

PROTECTIVE EQUIPMENT

VENTILATION:
PROCESS ENCLOSURE RECOMMENDED TO MEET PUBLISHED EXPOSURE LIMITS.

RESPIRATOR:
THE FOLLOWING RESPIRATORS AND MAXIMUM USE CONCENTRATIONS ARE RECOMMENDATIONS BY THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, NIOSH POCKET GUIDE TO CHEMICAL HAZARDS OR NIOSH CRITERIA DOCUMENTS, OR DEPARTMENT OF LABOR, 29CFR1910 SUBPART 2.
THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE AND BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE OF OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION.

SULFURIC ACID:

25 MG/M3- ANY POWERED AIR-PURIFYING RESPIRATOR WITH AN ACID GAS CARTRIDGE(S) AND HAVING A HIGH-EFFICIENCY PARTICULATE FILTER.
ANY SUPPLIED-AIR RESPIRATOR OPERATED IN A CONTINUOUS FLOW MODE.

50 MG/M3- ANY CHEMICAL CARTRIDGE RESPIRATOR WITH A FULL FACEPIECE AND ACID GAS CARTRIDGE(S) IN COMBINATION WITH A HIGH-EFFICIENCY PARTICULATE FILTER.
ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE.
ANY SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE.
ANY AIR-PURIFYING FULL FACEPIECE RESPIRATOR (GAS MASK) WITH A

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80 MG/M3- ANY SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE AND OPERATED IN A
PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ESCAPE- ANY AIR-PURIFYING FULL FACEPIECE RESPIRATOR (GAS MASK) WITH A
CHIN-STYLE OR FRONT- OR BACK-MOUNTED ACID GAS CANISTER HAVING A
HIGH-EFFICIENCY PARTICULATE FILTER.
ANY APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE
DEMAND OR OTHER POSITIVE PRESSURE MODE.

SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND
OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY
SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER
POSITIVE PRESSURE MODE.

CLOTHING:

WEAR APPROPRIATE PROTECTIVE CLOTHING TO AVOID ANY POSSIBILITY OF SKIN CONTACT
WITH LIQUIDS CONTAINING MORE THAN 1% SULFURIC ACID. AVOID REPEATED OR
PROLONGED SKIN CONTACT WITH LIQUIDS CONTAINING 1% OR LESS SULFURIC ACID.

GLOVES:

EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS
SUBSTANCE.

EYE PROTECTION:

EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES AND A
FACESHIELD TO PREVENT CONTACT WITH THIS SUBSTANCE. CONTACT LENSES SHOULD NOT
BE WORN.

EMERGENCY WASH FACILITIES:

WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES AND/OR SKIN MAY BE
EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN
AND QUICK DRENCH SHOWER WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

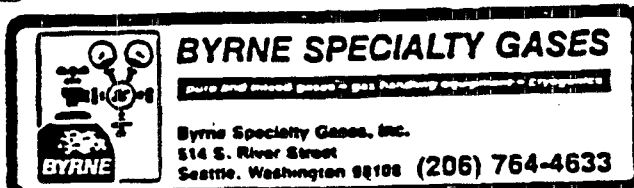
AUTHORIZED - FISHER SCIENTIFIC GROUP, INC.
CREATION DATE: 11/28/84 REVISION DATE: 12/21/88

-ADDITIONAL INFORMATION-

THE INFORMATION BELOW IS BELIEVED TO BE ACCURATE AND REPRESENTS THE BEST
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SHOULD MAKE THEIR OWN INVESTIGATIONS TO DETERMINE THE SUITABILITY OF THE
INFORMATION FOR THEIR PARTICULAR PURPOSES.

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Specialty Gas Material Safety Data Sheet

EMERGENCY PHONE (800) 523-8374 IN PENNSYLVANIA (800) 322-8082	PRODUCT NAME ISOBUTYLENE	CAS #115-11-7
AIR PRODUCTS AND CHEMICALS, INC. BOX 538 ALLENTOWN, PA 18105 (215) 481-8257	TRADE NAME AND SYNONYMS Isobutylene	
	CHEMICAL NAME AND SYNONYMS Isobutylene, Isobutene, 2-Methylpropene	
ISSUE DATE AND REVISIONS 04/78, 06/85	FORMULA (iso) C ₄ H ₈	CHEMICAL FAMILY Alkene

HEALTH HAZARD DATA

TIME WEIGHTED AVERAGE EXPOSURE LIMIT See last page.
SYMPTOMS OF EXPOSURE <p>Inhalation: Moderate concentrations which exclude an adequate supply of oxygen to the lungs cause dizziness, drowsiness and eventual unconsciousness. It also has a very mild anesthetic effect which might cause lack of coordination or lessened mental alertness.</p> <p>Skin and Eye Contact: It is mildly irritating to mucous membranes. Due to its rapid rate of evaporation, isobutylene can cause tissue freezing or frostbite on contact.</p>
TOXICOLOGICAL PROPERTIES <p>Isobutylene has a very mild anesthetic effect, however, the major health hazard is the exclusion of an adequate supply of oxygen to the lungs.</p> <p>Frostbite effects are a change in color of the skin to gray or white possibly followed by blistering.</p>
RECOMMENDED FIRST AID TREATMENT <p>PROMPT MEDICAL ATTENTION IS REQUIRED IN ALL CASES OF OVEREXPOSURE TO ISOBUTYLENE. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS AND MUST BE AWARE OF EXTREME FIRE AND EXPLOSION HAZARD.</p> <p>Inhalation: Move exposed personnel to an uncontaminated area. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Medical assistance should be sought immediately.</p> <p>Skin Contact or Frostbite: Remove contaminated clothing and flush affected areas with lukewarm water. DO NOT USE HOT WATER. A physician should see the patient promptly if the cryogenic "burn" has caused blistering of the skin or deep tissue freezing.</p>

Information contained in this material safety data sheet is offered without charge for use by technically qualified personnel at their discretion and risk. All statements, technical information and recommendations contained herein are based on tests and data which we believe to be reliable, but the accuracy or completeness thereof is not guaranteed and no warranty of any kind is made with respect thereto. This information is not intended as a license to operate under or a recommendation to practice or infringe any patent of this Company or others covering any process, composition of matter or use.

Since the Company shall have no control of the use of the product described herein, the Company assumes no liability for loss or damage incurred from the proper or improper use of such product.

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HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES
Isobutylene is flammable over a wide range in air.

PHYSICAL DATA

BOILING POINT 19.6°F (−6.9°C)	LIQUID DENSITY AT BOILING POINT 39.1 lb/ft³ (626 kg/m³)
VAPOR PRESSURE @ 70°F (21.1°C) = 39 psia (269 kPa)	GAS DENSITY AT 70°F, 1 atm 0.148 lb/ft³ (2.37 kg/m³)
SOLUBILITY IN WATER Insoluble	FREEZING POINT − 220.6°F (− 140.3°C)
APPEARANCE AND ODOR Colorless gas with an unpleasant odor similar to that which is emitted when burning anthracite coal.	

FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used) See last page.	AUTO IGNITION TEMPERATURE 869°F (465°C)	FLAMMABLE LIMITS % BY VOLUME LEL 1.8 UEL 9.6
EXTINGUISHING MEDIA Water, carbon dioxide, dry chemical		ELECTRICAL CLASSIFICATION Class 1, Group not specific
SPECIAL FIRE FIGHTING PROCEDURES Keep cylinder(s) cool with water spray from a distance. If possible without risk, move cylinder(s) away from fire area. If possible without risk, stop the flow of gas to a fire. Allow gas fire to burn itself out. (Continued on last page)		
UNUSUAL FIRE AND EXPLOSION HAZARDS Isobutylene is denser than air and can travel considerable distances to an ignition source and flash back. Cylinder(s) may explode or vent when exposed to fire.		

REACTIVITY DATA

STABILITY Unstable		CONDITIONS TO AVOID
Stable	X	
INCOMPATIBILITY (Materials to avoid) Oxidizers		
HAZARDOUS DECOMPOSITION PRODUCTS None		
HAZARDOUS POLYMERIZATION May Occur		CONDITIONS TO AVOID
Will Not Occur	X	

SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Evacuate all personnel from affected area. Use appropriate protective equipment. If leak is in user's equipment, be certain to purge piping with an inert gas prior to attempting repairs. If leak is in container or container valve, call the "800" emergency phone number listed herein.

WASTE DISPOSAL METHOD

All Federal, State and Local regulations regarding health and pollution should be followed in waste disposal. Contact Air Products for specific recommendations. Do not dispose of unused quantities.

(Continued on last page)

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SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type) Positive pressure air line with mask or self-contained breathing apparatus should be available for emergency use.

VENTILATION Hood with forced ventilation	LOCAL EXHAUST To prevent accumulation above the LEL	SPECIAL
	MECHANICAL (Gen.) In accordance with electrical codes	OTHER
PROTECTIVE GLOVES Plastic or rubber		
EYE PROTECTION Safety goggles or glasses		
OTHER PROTECTIVE EQUIPMENT Safety shoes, safety shower, eyewash "fountain."		

SPECIAL PRECAUTIONS*

SPECIAL LABELING INFORMATION

DOT Shipping Name: Liquefied petroleum gas DOT Hazard Class: Flammable gas

DOT Shipping Label: Flammable gas ID No.: UN 1075

SPECIAL HANDLING RECOMMENDATIONS

Use only in well-ventilated areas. Valve protection caps must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a pressure reducing regulator when connecting cylinder to lower pressure (< 250 psig) piping or systems. Do not heat cylinder by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder.

For additional recommendations consult the Air Products Specialty Gas Catalog Safety and Technical Information Section or Compressed Gas Association Pamphlet P-1.

SPECIAL STORAGE RECOMMENDATIONS

Protect cylinders from physical damage. Store in cool, dry, well-ventilated area of non-combustible construction away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are stored to exceed 130°F (54°C). Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Full and empty cylinders should be segregated. Use a "first in-first out" inventory system to prevent full cylinders being stored for excessive periods of time. Post "No Smoking or Open Flames" signs in the storage or use area. There should be no sources of ignition in the storage or use area.

For additional recommendations consult the Air Products Specialty Gas Catalog Safety and Technical Information Section or Compressed Gas Association Pamphlet P-1.

SPECIAL PACKAGING RECOMMENDATIONS

Isobutylene is noncorrosive and may be used with any common structural material.

OTHER RECOMMENDATIONS OR PRECAUTIONS

Earth-ground and bond all lines and equipment associated with the isobutylene system. Electrical equipment should be non-sparking or explosion proof. Compressed gas cylinders should not be refilled except by qualified producers of compressed gases. Shipment of a compressed gas cylinder which has not been filled by the owner with his (written) consent is a violation of Federal Law (49CFR).

*Various Government agencies (i.e., Department of Transportation, Occupational Safety and Health Administration, Food and Drug Administration and others) may have specific regulations concerning the transportation, handling, storage or use of this product which will not be reflected in this data sheet. The customer should review these regulations to ensure that he is in full compliance.

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TIME WEIGHTED AVERAGE EXPOSURE LIMIT (Continued)

Isobutylene is defined as a simple asphyxiant. Oxygen levels should be maintained at greater than 18 molar percent at normal atmospheric pressure which is equivalent to a partial pressure of 135 mm Hg. (ACGIH 1984-85)

FLASH POINT (Method Used) (Continued)

— 105°F (— 76°C) Closed Cup

SPECIAL FIRE FIGHTING PROCEDURES (Continued)

Ventilate low areas where flammable or explosive mixtures may form.

WASTE DISPOSAL METHOD (Continued)

Return the properly labeled shipping container to Air Products for disposal with valve(s) tightly closed, outlet seal(s) secured and valve protection cap in place. For emergency disposal assistance, call the "800" emergency phone number listed herein.

J.T.BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865

M A T E R I A L S A F E T Y D A T A S H E E T

24-HOUR EMERGENCY TELEPHONE -- (201) 859-2151

CHEMTREC # (800) 424-9300 -- NATIONAL RESPONSE CENTER # (800) 424-8802

M2015 D06

METHANOL

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EFFECTIVE: 05/01/89

ISSUED: 05/16/89

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (CLOSED CUP): 12 C (54 F)

NFPA 704M RATING: 1-3-0

AUTOIGNITION TEMPERATURE: 463 C (867 F)

FLAMMABLE LIMITS: UPPER - 36.0 % LOWER - 6.0 %

FIRE EXTINGUISHING MEDIA

USE ALCOHOL FOAM, DRY CHEMICAL OR CARBON DIOXIDE. (WATER MAY BE INEFFECTIVE.)

SPECIAL FIRE-FIGHTING PROCEDURES

FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE. MOVE CONTAINERS FROM FIRE AREA IF IT CAN BE DONE WITHOUT RISK. USE WATER TO KEEP FIRE-EXPOSED CONTAINERS COOL.

UNUSUAL FIRE & EXPLOSION HAZARDS

VAPORS MAY FLOW ALONG SURFACES TO DISTANT IGNITION SOURCES AND FLASH BACK. CLOSED CONTAINERS EXPOSED TO HEAT MAY EXPLODE. CONTACT WITH STRONG OXIDIZERS MAY CAUSE FIRE. BURNS WITH A CLEAR, ALMOST INVISIBLE FLAME.

TOXIC GASES PRODUCED

CARBON MONOXIDE, CARBON DIOXIDE, FORMALDEHYDE

EXPLOSION DATA-SENSITIVITY TO MECHANICAL IMPACT

NONE IDENTIFIED.

EXPLOSION DATA-SENSITIVITY TO STATIC DISCHARGE

NONE IDENTIFIED.

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE (TLV/TWA): 260 MG/M3 (200 PPM)

THE TLV LISTED DENOTES TLV (SKIN).

SHORT-TERM EXPOSURE LIMIT (STEL): 310 MG/M3 (250 PPM)

PERMISSIBLE EXPOSURE LIMIT (PEL): 260 MG/M3 (200 PPM)

CONTINUED ON PAGE: 4

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J.T.BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865
M A T E R I A L S A F E T Y D A T A S H E E T
24-HOUR EMERGENCY TELEPHONE -- (201) 859-2151
CHEMTREC # (800) 424-9300 -- NATIONAL RESPONSE CENTER # (800) 424-8800

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METHANOL

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EFFECTIVE: 05/01/89

ISSUED: 05/16

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SECTION V - HEALTH HAZARD DATA (CONTINUED)

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TOXICITY OF COMPONENTS

ORAL RAT LD50 FOR METHANOL	5628 MG/
INTRAPERITONEAL RAT LD50 FOR METHANOL	954C MG/
SUBCUTANEOUS MOUSE LD50 FOR METHANOL	9800 MG/
SKIN RABBIT LD50 FOR METHANOL	20 G/K
CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO CSHA REG: NO	

CARCINOGENICITY
NONE IDENTIFIED.

REPRODUCTIVE EFFECTS
NONE IDENTIFIED.

EFFECTS OF OVEREXPOSURE

INHALATION: IS HARMFUL AND MAY BE FATAL, HEADACHE, NAUSEA, VOMITING, DIZZINESS, NARCOSIS, RESPIRATORY FAILURE, LOW BLOOD PRESSURE, CENTRAL NERVOUS SYSTEM DEPRESSION

SKIN CONTACT: IRRITATION, PROLONGED CONTACT MAY CAUSE DERMATITIS

EYE CONTACT: IRRITATION, MAY CAUSE TEMPORARY CORNEAL DAMAGE

SKIN ABSORPTION: NONE IDENTIFIED

INGESTION: IS HARMFUL AND MAY BE FATAL, BLINDNESS, HEADACHE, NAUSEA, VOMITING, DIZZINESS, GASTROINTESTINAL IRRITATION, CENTRAL NERVOUS SYSTEM DEPRESSION, HEARING LOSS

CHRONIC EFFECTS: KIDNEY DAMAGE, LIVER DAMAGE

TARGET ORGANS

EYES, SKIN, CENTRAL NERVOUS SYSTEM, GI TRACT, RESPIRATORY SYSTEM, LUNGS

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

EYE DISORDERS, SKIN DISORDERS, LIVER OR KIDNEY DISORDERS

PRIMARY ROUTES OF ENTRY

INHALATION, INGESTION, EYE CONTACT, SKIN CONTACT, ABSORPTION

CONTINUED ON PAGE: 5

AR000862

J.T.BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865

M A T E R I A L S A F E T Y D A T A S H E E T

24-HOUR EMERGENCY TELEPHONE -- (201) 859-2151

CHEMTREC # (800) 424-9300 -- NATIONAL RESPONSE CENTER # (800) 424-8802

M2015 D06

METHANOL

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SECTION V - HEALTH HAZARD DATA (CONTINUED)

EMERGENCY AND FIRST AID PROCEDURES

INGESTION: CALL A PHYSICIAN. IF SWALLOWED, IF CONSCIOUS, GIVE LARGE AMOUNTS OF WATER. INDUCE VOMITING.

INHALATION: IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

SKIN CONTACT: IN CASE OF CONTACT, IMMEDIATELY FLUSH SKIN WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED CLOTHING AND SHOES. WASH CLOTHING BEFORE RE-USE.

EYE CONTACT: IN CASE OF EYE CONTACT, IMMEDIATELY FLUSH WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES.

SARA/TITLE III HAZARD CATEGORIES AND LISTS

ACUTE: YES CHRONIC: YES FLAMMABILITY: YES PRESSURE: NO REACTIVITY: NO

EXTREMELY HAZARDOUS SUBSTANCE: NO

CERCLA HAZARDOUS SUBSTANCE: YES CONTAINS METHANOL (RC = 5000 LBS)

TOXIC CHEMICALS: YES CONTAINS METHANOL

GENERIC CLASS: C05

TSCA INVENTORY: YES

SECTION VI - REACTIVITY DATA

STABILITY: STABLE

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: HEAT, FLAME, OTHER SOURCES OF IGNITION

INCOMPATIBLES: STRONG OXIDIZING AGENTS, STRONG ACIDS, ZINC, ALUMINUM, MAGNESIUM

DECOMPOSITION PRODUCTS: CARBON MONOXIDE, CARBON DIOXIDE, FORMALDEHYDE

CONTINUED ON PAGE: 6

AR000863

J.T.BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBLRG, NJ 08865
M A T E R I A L S A F E T Y D A T A S H E E T
24-HOUR EMERGENCY TELEPHONE -- (201) 859-2151
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SECTION VII - SPILL & DISPOSAL PROCEDURES

=====

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE

WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING. STOP OFF IGNITION SOURCES; NO FLARES, SMOKING OR FLAMES IN AREA. STOP LEAK YOU CAN DO SO WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. TAKE UP WITH SAND OR OTHER NON-COMBUSTIBLE ABSORBENT MATERIAL AND PLACE INTO CONTAINER FOR LATER DISPOSAL. FLUSH AREA WITH WATER.

J. T. BAKER SOLUSORB(R) SOLVENT ADSORBENT IS RECOMMENDED FOR SPILLS OF THIS PRODUCT.

DISPOSAL PROCEDURE

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

EPA HAZARDOUS WASTE NUMBER: U154 (TOXIC WASTE)

=====

SECTION VIII - INDUSTRIAL PROTECTIVE EQUIPMENT

=====

VENTILATION: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TL REQUIREMENTS.

RESPIRATORY PROTECTION: RESPIRATORY PROTECTION REQUIRED IF AIRBORNE CONCENTRATION EXCEEDS TLV. AT CONCENTRATIONS ABOVE 200 PPM, A SELF-CONTAINED BREATHING APPARATUS IS ADVISED.

EYE/SKIN PROTECTION: SAFETY GOGGLES AND FACE SHIELD, UNIFORM, PROTECTIVE SUIT, RUBBER GLOVES ARE RECOMMENDED.

=====

SECTION IX - STORAGE AND HANDLING PRECAUTIONS

=====

SAF-T-DATA* STORAGE COLOR CODE: RED (FLAMMABLE)

STORAGE REQUIREMENTS

KEEP CONTAINER TIGHTLY CLOSED. STORE IN A COOL, DRY, WELL-VENTILATED, FLAMMABLE LIQUID STORAGE AREA.

SPECIAL PRECAUTIONS

BOND AND GROUND CONTAINERS WHEN TRANSFERRING LIQUID.

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J.T.BAKER INC. 222 RED SCHCCL LANE, PHILLIPSBURG, NJ 08865

M A T E R I A L S A F E T Y D A T A S H E E T

24-HOUR EMERGENCY TELEPHONE -- (201) 859-2151

CHEMTREC # (800) 424-9300 -- NATIONAL RESPONSE CENTER # (800) 424-8802

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METHANOL

PAGE: 7

EFFECTIVE: 05/01/89

ISSUED: 05/16/89

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SECTION X - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

=====

DOMESTIC (D.C.T.)

PROPER SHIPPING NAME: METHYL ALCOHOL
HAZARD CLASS: FLAMMABLE LIQUID
UN/NA: UN1230 REPORTABLE QUANTITY: 5000 LBS.
LABELS: FLAMMABLE LIQUID
REGULATORY REFERENCES: 49CFR 172.101; 173.119

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME: METHANOL
HAZARD CLASS: 3.2
UN: UN1230 MARINE POLLUTANTS: NO
LABELS: FLAMMABLE LIQUID, POISON
REGULATORY REFERENCES: 49CFR 172.102; PART 176; IMO

I.M.C. PAGE: 3087
PACKAGING GROUP: II

AI (I.C.A.O.)

PROPER SHIPPING NAME: METHANOL
HAZARD CLASS: 3.2
UN: UN1230
LABELS: FLAMMABLE LIQUID, POISON
REGULATORY REFERENCES: 49CFR 172.101; 173.6; PART 175; ICAO/IATA

PACKAGING GROUP: II

U.S. CUSTOMS HARMONIZATION NUMBER: 29051100009

=====

N/A = NOT APPLICABLE OR NOT AVAILABLE

N/E = NOT ESTABLISHED

THE INFORMATION IN THIS MATERIAL SAFETY DATA SHEET MEETS THE REQUIREMENTS OF THE UNITED STATES OCCUPATIONAL SAFETY AND HEALTH ACT AND REGULATIONS PROMULGATED THEREUNDER (29 CFR 1910.1200 ET. SEQ.) AND THE CANADIAN WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM. THIS DOCUMENT IS INTENDED ONLY AS A GUIDE TO THE APPROPRIATE PRECAUTIONARY HANDLING OF THE MATERIAL BY A PERSON TRAINED IN, OR SUPERVISED BY A PERSON TRAINED IN, CHEMICAL HANDLING. THE USER IS RESPONSIBLE FOR DETERMINING THE PRECAUTIONS AND DANGERS OF THIS CHEMICAL FOR HIS OR HER PARTICULAR APPLICATION. DEPENDING ON USAGE, PROTECTIVE CLOTHING INCLUDING EYE AND FACE GUARDS AND RESPIRATORS MUST BE USED TO AVOID CONTACT WITH MATERIAL OR BREATHING CHEMICAL VAPORS/FUMES.

EXPOSURE TO THIS PRODUCT MAY HAVE SERIOUS ADVERSE HEALTH EFFECTS. THIS CHEMICAL MAY INTERACT WITH OTHER SUBSTANCES. SINCE THE POTENTIAL USES

CONTINUED ON PAGE: 3

AR000865

J.T.BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865
M A T E R I A L S A F E T Y D A T A S H E E T
24-HOUR EMERGENCY TELEPHONE -- (201) 859-2151
CHEMTREC # (800) 424-9300 -- NATIONAL RESPONSE CENTER # (800) 424-8800

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METHANOL

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ISSUED: C5/16

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ARE SO VARIED, BAKER CANNOT WARN OF ALL OF THE POTENTIAL DANGERS OF USE OR INTERACTION WITH OTHER CHEMICALS OR MATERIALS. BAKER WARRANTS THAT THE CHEMICAL MEETS THE SPECIFICATIONS SET FORTH ON THE LABEL. BAKER DISCLAIMS ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED WITH REGARD TO THE PRODUCT SUPPLIED HEREUNDER, ITS MERCHANTABILITY OR ITS FITNESS FOR A PARTICULAR PURPOSE. THE USER SHOULD RECOGNIZE THAT THIS PRODUCT CAN CAUSE SEVERE INJURY AND EVEN DEATH, ESPECIALLY IF IMPROPERLY HANDLED OR THE KNOWN DANGERS OF USE ARE NOT HEEDDED. READ ALL PRECAUTIONARY INFORMATION. AS NEW DOCUMENTED GENERAL SAFETY INFORMATION BECOMES AVAILABLE, BAKER WILL PERIODICALLY REVISE THIS MATERIAL SAFETY DATA SHEET. IF YOU HAVE ANY QUESTIONS, PLEASE CALL CUSTOMER SERVICE (1-800-JTBAKER) FOR ASSISTANCE.

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APPROVED BY QUALITY ASSURANCE DEPARTMENT.

-- LAST PAGE --

AR000866

MALLINCKRODT

Material Safety Data Sheet

Mallinckrodt, Inc. Science Products Division, P.O. Box M Paris, KY 40361

METHYL ALCOHOL

PRODUCT IDENTIFICATION:

Synonyms: Wood alcohol; methanol; carbinol
Formula CAS No.: 67-56-1
Molecular Weight: 32.04
Chemical Formula: CH₃OH
Hazardous Ingredients: Methyl alcohol

PRECAUTIONARY MEASURES

DANGER! MAY BE FATAL IF SWALLOWED.
HARMFUL IF INHALED. VAPOR HARMFUL. FLAMMABLE!
MAY CAUSE BLINDNESS. CANNOT BE MADE NONPOISONOUS.
CAUSES IRRITATION.

Keep away from heat, sparks and flame.
Avoid breathing vapor.
Keep container closed.
Use with adequate ventilation.
Wash thoroughly after handling.

EMERGENCY/FIRST AID

In all cases call a physician immediately. If swallowed, induce vomiting immediately by giving two glasses of water and sticking finger down throat. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes.
SEE SECTION 5.

DOT Hazard Class: Flammable Liquid

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SECTION 1 Physical Data

Appearance: Clear, colorless liquid.
Odor: Characteristic odor.
Solubility: Miscible with water.
Boiling Point: 64.5°C (148°F)
Melting Point: -98°C (-144°F)
Specific Gravity: 0.8
Vapor Density (Air=1): 1.1
Vapor Pressure (mm Hg): 97 @ 20°C (68°F)
Evaporation Rate: (BuAc=1): 5.9

SECTION 2 Fire and Explosion Information

Fire:
Flammable. Flashpoint: 11°C (52°F) (CC).
Autoignition temperature: 385°C (725°F).
Flammable limits, in air, % by volume:
lcl = 6.7; ucl = 36.

Explosion:
Above flash point, vapor-air mixtures are explosive within flammable limits noted above. Moderate explosion hazard and dangerous fire hazard when exposed to heat, sparks or flames.

Fire Extinguishing Media:
Water spray, dry chemical, alcohol foam, or carbon dioxide.

Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Use water spray to blanket fire, cool fire exposed containers, and to flush non-ignited spills or vapors away from fire. Vapors can flow along surfaces to distant ignition source and flash back.

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Emergency Telephone Number: 314-982-5000

SECTION 3 Reactivity Data

Stability:
Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:
Carbon oxides and formaldehyde may form when heated to decomposition.

Hazardous Polymerization:
This substance does not polymerize.

Incompatibilities:
Strong oxidizing agents such as nitrates, perchlorates or sulfuric acid. Will attack some forms of plastics, rubber, and coatings. May react with metallic aluminium and generate hydrogen gas.

SECTION 4 Leak/Spill Disposal Information

Ventilate area of leak or spill. Remove all sources of ignition. Clean-up personnel require protective clothing and respiratory protection from vapors. Contain and recover liquid when possible. Collect as hazardous waste and atomize in a suitable RCRA approved combustion chamber, or absorb with vermiculite, dry sand, earth or similar material for disposal as hazardous waste in a RCRA approved facility. Do not flush to sewer.

Reportable Quantity (RQ)(CWA/CERCLA): 5000 lbs.

Ensure compliance with local, state and federal regulations.

AR000867

NFPA Ratings: Health: 1 Flammability: 3 Reactivity: 0

METHYL ALCOHOL

Kathleen Lamb



METHYL ALCOHOL

SECTION 5 Health Hazard Information

A. EXPOSURE / HEALTH EFFECTS

Inhalation:

A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Once absorbed into the body, it is very slowly eliminated. Symptoms of overexposure may include headache, drowsiness, nausea, vomiting, blurred vision, blindness, coma, and death. A person may get better but then worse again up to 30 hours later.

Ingestion:

Toxic. Symptoms parallel inhalation. Can intoxicate and cause blindness. Usual fatal dose: 100-125 milliliters.

Skin Contact:

Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure.

Eye Contact:

Irritant. Continued exposure may cause eye lesions.

Chronic Exposure:

Marked impairment of vision and enlargement of the liver has been reported. Repeated or prolonged exposure may cause skin irritation.

Aggravation of Pre-existing Conditions:

Persons with pre-existing skin disorders or eye problems or impaired liver or kidney function may be more susceptible to the effects of the substance.

B. FIRST AID

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Ingestion:

If swallowed, induce vomiting immediately by giving two glasses of water and sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.

Skin Exposure:

Remove any contaminated clothing. Wash skin with soap or mild detergent and water for at least 15 minutes. Get medical attention if irritation develops or persists.

Eye Exposure:

Wash eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

C. TOXICITY DATA

(RTECS, 1986)

Oral rat LD50: 5628 mg/kg. Skin rabbit: 20 gm/kg.

Aquatic toxicity rating TLm %: Over 1,000. Mutation data cited. Reproductive effects data cited.

SECTION 6 Occupational Control Measures

Airborne Exposure Limits:

-OSHA Permissible Exposure Limit (PEL):
200 ppm (TWA), 250 ppm (STEL) skin

-ACGIH Threshold Limit Value (TLV):
200 ppm (TWA), 250 ppm (STEL) skin

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, "Industrial Ventilation, A Manual of Recommended Practices", most recent edition, for details.

Personal Respirators: (NIOSH Approved)

If the TLV is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or self-contained breathing apparatus.

Skin Protection:

Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure.

Eye Protection:

Use chemical safety goggles. Contact lenses should not be worn when working with this material. Maintain eye wash fountain and quick-drench facilities in work area.

SECTION 7 Storage and Special Information

Protect against physical damage. Outside or detached storage is preferred. Inside storage should be in a standard flammable liquids storage room or cabinet. Separate from oxidizing materials. Storage and use areas should be No Smoking areas.

Spark-proof tools and explosion-proof equipment should be used in the storage and handling area.

.....
METOL

AR000868

M A T E R I A L S A F E T Y D A T A S H E E T

EM SCIENCE
A DIVISION OF EM INDUSTRIES
P.O. BOX 70
480 DEMOCRAT RD.
GIBBSTOWN, N.J. 08027

PREPARATION DATE: JUN 28, '89
DATE SENT TO CUSTOMER.....: DEC 20, '89
INFORMATION PHONE NUMBER :
(609) 354-9200
CHEMTREC EMERGENCY NUMBER:
1-800-424-9300

----- NFPA HAZARD RATINGS

HEALTH: 1 FLAMMABILITY: 3
REACTIVITY : 0 SPECIAL HAZARDS.:

SECTION I - GENERAL INFORMATION

CATALOG NUMBER(S): HX0293 HX0294 HX0296 HX0297 HXC298
 HX0299P HX0299S HX0300 HX0310 HX029C HX0292
 9687 HX0295T
CHEMICAL NAME.....: HEXANE
TRADE NAME.....: HEXANES
C.A.S. NUMBER.....: 110-54-3
CHEMICAL FAMILY...: ALIPHATIC HYDROCARBON
FORMULA.....: C₆H₁₄
MOLECULAR WEIGHT.: 86.18
DOT SHIPPING NAME: HEXANE
DOT NUMBER.....: UN1208

SECTION II - HAZARDOUS INGREDIENTS

COMPONENT	CAS#	APPROX. %	PEL (TWA)	TLV (TWA)
N-HEXANE	110-54-3	85-90	50 PPM	50 PPM
METHYLCYCLOPENTANE	96-37-7	5-10	NE	NE
METHYLPENTANES	NE	0-5	NE	NE

NE = NONE ESTABLISHED

MAY CONTAIN TRACE LEVELS (0.0002%) OF BENZENE.

SECTION III- PHYSICAL DATA

BOILING POINT (C 760 MM HG): 65C
MELTING POINT (C).....: - 95C
SPECIFIC GRAVITY(H₂O = 1).....: 0.6603
VAPOR PRESSURE..(MM HG).....: 125 20C

MSDS-HX0290

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THE STATEMENTS CONTAINED HEREIN ARE OFFERED FOR INFORMATIONAL PURPOSES ONLY AND ARE BASED UPON TECHNICAL DATA THAT EM SCIENCE BELIEVES TO BE ACCURATE. IT IS INTENDED FOR USE ONLY BY PERSONS HAVING THE NECESSARY TECHNICAL SKILL AND AT THEIR OWN DISCRETION AND RISK. SINCE CONDITIONS AND MANNER OF USE ARE OUTSIDE OUR CONTROL, WE MAKE NO WARRANTY, EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS OR OTHERWISE.

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PERCENT VOLATILE BY VOL (%): 100
VAPOR DENSITY (AIR=1): 3.0
EVAPORATION RATE (BUAC=1): 9.0
SOLUBILITY IN WATER (%): SLIGHT
APPEARANCE AND ODOR: CLEAR, COLORLESS LIQUID,
CHARACTERISTIC ODOR

SECTION IV - FIRE & EXPLCSION HAZARD DATA

FLASH POINT (F): -7F (CC)
FLAMMABLE LIMITS LEL %: 1.2
FLAMMABLE LIMITS UEL %: 7.5
EXTINGUISHING MEDIA: CO.2., DRY CHEMICAL, FOAM
FIRE FIGHTING PROC:
WEAR SELF-CONTAINED BREATHING APPARATUS.
FIRE & EXPL. HAZARDS:
DANGEROUS FIRE AND EXPLCSION HAZARD.
VAPOR CAN TRAVEL DISTANCES TO IGNITION SOURCE AND FLASH BACK.

SECTION V - HEALTH HAZARD DATA (ACUTE AND CHRONIC)

ACGIH TLV/OSHA PEL (TWA): SEE SECTION II
TOXICITY DATA:
-IHL-HMN TCLO: 5000 PPM/10M GRL-RAT LD50: 28710 MG/KG
SYMPTOMS OF EXPOSURE:
TOXIC BY INGESTION AND INHALATION.
VAPOR INHALATION CAUSES IRRITATION OF NASAL AND RESPIRATORY PASSAG
HEADACHE, DIZZINESS, NAUSEA, CENTRAL NERVOUS SYSTEM DEPRESSION.
CHRONIC OVEREXPOSURE CAN CAUSE SEVERE NERVE DAMAGE.
MAY CAUSE IRRITATION ON CONTACT WITH SKIN OR EYES.
MAY CAUSE DAMAGE TO KIDNEYS.
MEDICAL COND. AGGRAVATED BY EXP: KIDNEY, RESPIRATORY AND CNS CONDIT
ROUTES OF ENTRY: INHALATION, INGESTION OR SKIN CCNTAC
CARCINOGENICITY:
THE MATERIAL IS NOT LISTED AS A CANCER CAUSING AGENT.
EMERGENCY FIRST AID:
GET MEDICAL ASSISTANCE FOR ALL CASES OF OVEREXPOSURE
EYES: IMMEDIATELY FLUSH THOROUGHLY WITH WATER FOR AT LEAST 15 MINU
SKIN: WASH THOROUGHLY WITH SOAP AND WATER.
INHALATION: REMOVE TO FRESH AIR; GIVE ARTIFICIAL RESPIRATION IF
BREATHING HAS STOPPED.
INGESTION: DO NOT INDUCE VOMITING; GET MEDICAL ATTENTION.

SECTION VI - REACTIVITY DATA

STABILITY: YES
CONDITIONS TO AVOID: HEAT; CONTACT WITH IGNITION SOURCE.

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MATERIALS TO AVOID.....: () WATER () ACIDS
() BASES () CORROSIVES (X) OXIDIZERS
() OTHER:

HAZARDOUS POLYMERIZATION.: DOES NOT OCCUR
HAZARDOUS DECOMPOSITION.: CO.X.

SECTION VII - ENVIRONMENTAL PROTECTION PROCEDURES

SPILL RESPONSE:

-DIKE SPILL; TAKE UP WITH ABSORBENT; CONTAINERIZE FOR PROPER DISPOSAL
WASTE DISPOSAL: TO BE PERFORMED IN COMPLIANCE WITH ALL CURRENT LOCAL,
STATE AND FEDERAL REGULATIONS.

SECTION VIII - SPECIAL PROTECTION INFORMATION

VENTILATION, RESPIRATORY PROTECTION, PROTECTIVE CLOTHING, EYE PROTECTION

-MATERIAL SHOULD BE HANDLED OR TRANSFERRED IN AN APPROVED FUME
HOOD OR WITH ADEQUATE VENTILATION

PROTECTIVE GLOVES (NITRILE, VITON OR EQUIVALENT) SHOULD BE WORN
TO PREVENT SKIN CONTACT

SAFETY GLASSES WITH SIDE SHIELDS SHOULD BE WORN AT ALL TIMES

NIOSH/MSHA-APPROVED RESPIRATOR SHOULD BE WORN IN THE ABSENCE OF
ADEQUATE VENTILATION.

SECTION IX - SPECIAL PRECAUTIONS

HANDLING & STORAGE

KEEP CONTAINER CLOSED.

STORE IN A COOL AREA AWAY FROM IGNITION SOURCES AND OXIDIZERS.

DO NOT BREATHE VAPOR.

DO NOT GET IN EYES, ON SKIN, OR ON CLOTHING.

ELECTRICALLY GROUND ALL EQUIPMENT WHEN HANDLING THIS PRODUCT

RETAINED RESIDUE MAY MAKE EMPTY CONTAINERS HAZARDOUS; USE CAUTION!

WORK/HYGIENIC PRACTICES: WASH THOROUGHLY AFTER HANDLING. DO NOT TAKE
INTERNALLY. EYE WASH AND SAFETY EQUIPMENT SHOULD BE READILY AVAILABLE!

SECTION X - OTHER INFORMATION

COMMENTS.....:

-TESTS ON LABORATORY ANIMALS INDICATE MATERIAL MAY PRODUCE ADVERSE
MUTAGENIC AND REPRODUCTIVE EFFECTS

REVISION HISTORY.....: 05/01/83, 9/26/86, 6/3/87, 8/28/87, 10/27/87
1/27/88, 11/29/88, 4/26/89

N/A = NOT AVAILABLE:

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AR000871

Baxter Healthcare Corporation
Burdick & Jackson Division
1953 South Harvey Street
Muskegon, MI 49442 USA

information/emergency telephone no. 616.726.3171
chemtrec telephone no. 800.424.9300
canadian emergency telephone no. 613.996.6666

MATERIAL SAFETY DATA SHEET

HEXANE

I. Identification

chemical name Hexane molecular weight 86.18
chemical family Aliphatic Hydrocarbon formula C₆H₁₄
synonyms n-Hexane
DOT proper shipping name Hexane
DOT hazard class Flammable Liquid
DOT identification no. UN1208 CAS no. 110-54-3

II. Physical and Chemical Data

boiling point, 760mm Hg. 68.7°C freezing point -95.3°C evaporation rate (BuAc=1) ca 10
vapor pressure at 20°C 124 mm Hg vapor density (air=1) 3.0 solubility in water @ 20°C 0.014%
% volatiles by volume ca 100 specific gravity (H₂O=1) @ 20°C 0.659 stability Stable
hazardous polymerization Not expected to occur.
appearance and odor Clear, colorless liquid with a mild hydrocarbon odor.
conditions to avoid Heat, sparks, open flame, open containers, and poor ventilation.

materials to avoid Strong oxidizing agents.

hazardous decomposition products Incomplete combustion can generate carbon monoxide and other toxic vapors.

III. Fire and Explosion Hazard Data

flash point, (test method) -26°C (Tag closed cup) auto ignition temperature 225°C
flammable limits in air % by volume: lower limit 1.1 upper limit 7.5
unusual fire and explosion hazards Very volatile and extremely flammable.

extinguishing media Carbon dioxide, dry chemical or foam.

special fire fighting procedures Water will not be effective in extinguishing a fire and may spread it, but a water spray can be used to cool exposed containers. Wear full protective clothing and self-contained breathing apparatus.
Heat will build pressure and may rupture closed storage containers.

IV. Hazardous Components

Hexane and isomers % ca 100 TLV 50 ppm CAS no. 110-54-3

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V. Health Hazards

Occupational Exposure Limits

OSHA TWA - 50 ppm
 STEL - not listed
 Ceiling - not listed

ACGIH TLV-TWA - 50 ppm
 TLV-STEL - not listed
 (15-min)

NIOSH 10 hour TWA - 100 ppm
 15 min Ceiling -510 ppm

Concentration Immediately Dangerous to Health

OSHA/NIOSH 5,000 ppm

Odor Threshold

NSC not listed
NIOSH not listed

Carcinogenic Data

Hexane is not listed as a carcinogen by IARC, NTP, OSHA, or ACGIH.

Primary Routes of Entry

Hexane may exert its effects through inhalation, skin absorption, and ingestion.

Industrial Exposure: Route of Exposure/Signs and Symptoms

Inhalation: Exposure can cause dizziness, numbness of extremities, and intoxication.

Eye Contact: Liquid and high vapor concentration can be irritating.

Skin Contact: Prolonged or repeated skin contact can cause irritation and dermatitis through defatting of skin.

Ingestion: Can cause gastrointestinal tract discomfort.

Effects of Overexposure

Hexane is a mild eye and mucous membrane irritant, primary skin irritant, central nervous system depressant and neurotoxin. Acute exposure causes irritation, narcosis, and gastrointestinal tract irritation. Chronic inhalation causes peripheral neuropathy. No systemic toxicity has been reported.

Medical Condition Aggravated by Exposure

Preclude from exposure those individuals susceptible to dermatitis.

AR000873

Emergency First Aid

- Inhalation:** Immediately remove to fresh air. If not breathing, administer mouth-to-mouth rescue breathing. If there is no pulse administer cardiopulmonary resuscitation (CPR). Contact physician immediately.
- Eye Contact:** Rinse with copious amounts of water for at least 15 minutes. Get emergency medical assistance.
- Skin Contact:** Flush thoroughly for at least 15 minutes. Wash affected skin with soap and water. Remove contaminated clothing and shoes. Wash clothing before re-use, and discard contaminated shoes. Get emergency medical assistance.
- Ingestion:** Call local Poison Control Center for assistance. Contact physician immediately. Aspiration Hazard - Do not induce vomiting.

VI. Safety Measures and Equipment

- Ventilation:** Adequate ventilation is required to protect personnel from exposure to chemical vapors exceeding the PEL and to minimize fire hazards. The choice of ventilation equipment, either local or general, will depend on the conditions of use, quantity of material, and other operating parameters.
- Respiratory:** Use approved respirator equipment. Follow NIOSH and equipment manufacturer's recommendations to determine appropriate equipment (air-purifying, air-supplied, or self-contained breathing apparatus).
- Eyes:** Safety glasses are considered minimum protection. Goggles or face shield may be necessary depending on quantity of material and conditions of use.
- Skin:** Protective gloves and clothing are recommended. The choice of material must be based on chemical resistance and other user requirements. Generally, neoprene or nitrile rubber offer acceptable chemical resistance. Individuals who are acutely and specifically sensitive to hexane may require additional protective equipment.

AR000874

Storage: Hexane should be protected from temperature extremes and direct sunlight. Proper storage of hexane must be determined based on other materials stored and their hazards and potential chemical incompatibility. In general, hexane should be stored in an acceptably protected and secure flammable liquid storage room.

Other: Emergency eye wash fountains and safety showers should be available in the vicinity of any potential exposure. Ground and bond metal containers to minimize static sparks.

VII. Spill and Disposal Data

Spill Control: Protect from ignition. Wear protective clothing and use approved respirator equipment. Absorb spilled material in an absorbent recommended for solvent spills and remove to a safe location for disposal by approved methods. If released to the environment, comply with all regulatory notification requirements.

Waste Disposal: Dispose of hexane as an EPA hazardous waste. Contact state environmental agency for listing of licensed hazardous waste disposal facilities and applicable regulations. Hazardous waste number: D001(Ignitable).

VIII. SARA/Title III Data

Hazard Classification

Immediate Health	Yes (irritant)
Delayed Health	Yes
Fire	Yes
Sudden Release	No
Reactive	No

Chemical Listings

Extremely Hazardous Substances	No
CERCLA Hazardous Substances	No
Toxic Chemicals	No

Hexane is not subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) and 40CFR Part 372. This product does not contain any other toxic chemical above 1% concentration or a carcinogen above 0.1% concentration.

Revision Date: July, 1989

KEY

ca Approximately
na Not applicable
C Ceiling

STEL Short Term Exposure Level (15 minutes)
TLV Threshold Limit Value
TWA Time Weighted Average (8 hours)
BuAc Butyl Acetate

CERCLA Comprehensive Environmental Response, Compensation and Liability Act
NSC National Safety Council ("Fundamentals of Industrial Hygiene," 3rd. Ed., 1988)

AR000875



Material Data Safety Sheet

Product: YSI 3168 Conductivity Calibrator 10,000 micromho/cm

Components	CAS #	%
Potassium Chloride	7447407	<1.0
Iodine, resublimed	7553562	<1.0

Balance - Water

The hazards associated with this product are those related to the constituent chemicals. Material Safety Data Sheets for these materials are attached.

*****Multiple Component Spill or Leak Procedures*****

Steps to take if material is released or spilled

Wear appropriate protective equipment.

Wipe up the spill with absorbent material.

Wash the spill area.

Waste Disposal

Dispose in accordance with local, state and federal regulations.

YSI, Inc.

October 30, 1990

AR000876

Appendix A
Site History from PRP's Work Plan

AR000877

SECTION 2

PHASE I - SITE BACKGROUND, SUMMARY OF EXISTING DATA

2.1 Site Location and History

The Transicoil Site encompasses approximately 50 acres and is located on Trooper Road, Worcester Township, Montgomery County, Pennsylvania (Figure 2-1). Since approximately 1952 until the present time, the facility has been used for the purpose of manufacturing DC and synchro electric motors, which are used by the aerospace industry. Since its inception in 1952, the business has been operated by various owners:

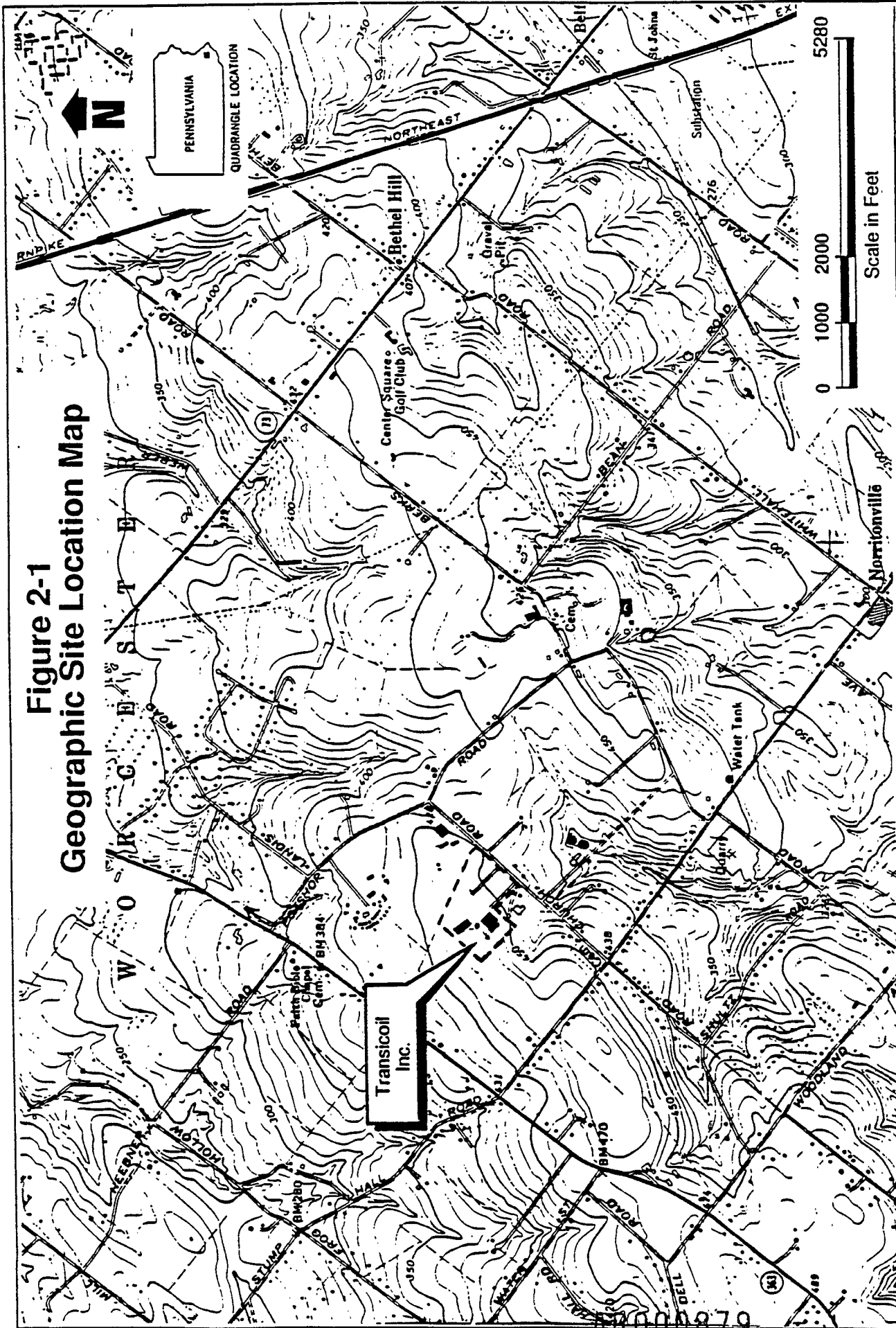
- 1950-1958 Messrs. Henderson and Connor.
- 1958-1964 Daystrom.
- 1964-1968 Weston Instruments.
- 1968-1972 Schlumberger/Weston.
- 1972-1979 Messrs. Meister, Rothchild, and Spagnoletti.
- 1979-1984 Portescap U.S.
- 1984-1987 The Kennard Group.
- 1987-present Eagle-Picher.

Various solvents have been used in small, limited quantities at the facility for the purpose of degreasing engine parts and equipment. One of the earliest solvents used was trichloroethylene (TCE) which was stored and used at the facility until approximately 1976. At that time the facility began to substitute trichloroethane (TCA) in the place of TCE for degreasing.

A former Nike Battery Site PH-191, owned by the United States Army, was located immediately adjacent to the Transicoil Site. This facility is also known to have used TCE and TCA from 1954 to 1968.

The Transicoil site first came to the attention of the regulatory authorities in 1979 when the Pennsylvania Department of Environmental Resources (PADER) performed an investigation which included the sampling of on-site soil, wastewater discharge, solvent tank contents and ground water, and off-site ground water from domestic wells. PADER's early analyses

Figure 2-1
Geographic Site Location Map



Notes:

Map from USGS 7.5 Minute Series
Lansdale, PA 1966

Drawn by / Date: D. Grabowski 2/5/90
Checked by / Date: B. [redacted] 5/18/90

Drawn by / Date: D. Grabowski 5/18/90
Checked by / Date: [redacted]

W0# 7510
AR0000879



indicated the presence of concentrations of TCE and TCA in on and off-site ground water, and in the Transicoil wastewater. Since the early 1980s, Transicoil has voluntarily performed several studies on its property to determine whether or not it is the source of the off-site TCE contamination and if so, the extent of the contamination.

In January of 1987 the Transicoil Site was proposed for inclusion on the National Priorities List. In June of 1989, Transicoil and Eagle-Picher Industries voluntarily entered into a consent agreement with the U.S. Environmental Protection Agency (EPA) to perform a focused Remedial Investigation/Feasibility Study (RI/FS) at the site. For the purposes of this work, the site is defined as the Transicoil facility which is defined as the property contained within the boundaries owned and operated by Eagle-Picher or Transicoil Incorporated.

2.2 Previous Investigations

2.2.1 PADER Investigation of 1979

On 19 September 1979, the Pennsylvania Department of Environmental Resources (PADER) conducted an inspection and search of the Transicoil property. During this inspection, samples were collected from ground water wells, soils, wastewater discharges, and contents of a waste solvent tank. These samples were submitted for chemical analysis for volatile organic compounds (VOCs). The results of the chemical analysis revealed the presence of TCE and 1,1,1-trichloroethane (1,1,1 TCA) in the samples collected from three septic system distribution boxes, two cooling water discharges, and three production wells located on the Transicoil property.

The PADER requested that Transicoil retain an environmental consultant to investigate the site, giving specific attention to the ground water contamination problem. Additionally, it was suggested that the investigation focus on the waste solvent tank and the on-site septic systems, which initially were believed to have contributed to the ground water and soils contamination at the site (from PADER reports).

In March of 1980, Betz, Converse, Murdoch Incorporated (BCM) of Plymouth Meeting, Pennsylvania was retained by Transicoil to undertake an initial investigation of the facility as it related to the TCE contamination of soils and ground water beneath the site.

2.2.2 BCM, Reports of 1980-82

During 1980, BCM, Inc. was retained by Transicoil to conduct a Phase I and Phase II site investigation, as recommended by the PADER. An "Interim Report on Phase I and II Hydrogeologic Investigations at the Transicoil Site" was submitted by BCM to Transicoil on 21 October 1980, summarizing the results of the investigations. The investigations included:

- analysis of one sample collected from an underground waste solvent tank;
- analysis of eight samples collected from the soils in which the waste solvent tank was buried;
- analysis of samples collected from underground septic system distribution boxes; and
- analysis of the soil samples collected from the septic system drainfield

High concentrations of each of these parameters were detected from the sample of the residual material in the waste solvent tank. However, the analysis of the soil samples taken from beneath the waste solvent tank showed that concentrations of TCE and perchloroethylene (PCE) were less than 0.1 ppm and that concentrations of 1,1,1-trichloroethane were less than 0.13 ppm, indicating no apparent leakage. The soils sampled from within the septic tank drainfield showed concentrations of TCE, PCE and 1,1,1-TCA up to 1 ppm, .21 ppm, and 140 ppm, respectively. These constituents were detected in one of each of the samples collected from the septic tank drainfield. A review of available records does not indicate past use of PCE at the site. However, PCE is a common contaminant of industrial grade TCE, which could account for its being found in soil samples at the site.

Based on the results of the Phase I and II investigations, the PADER conveyed to Transicoil that the presence of solvents in samples from the septic system confirmed it as a source of ground water contamination. However, they concluded that the solvent levels present did not constitute a major continuing source. Further, the PADER recommended that additional samples should be obtained from those areas which indicated the presence of solvents in soil samples, specifically in the vicinity of the septic drainfield.

In 1981, BCM collected ten additional soil samples at the septic system drainfield. This effort was considered to be an expansion of the Phase II investigation. These soil samples were taken at

the soil bedrock interface, approximately three feet below the ground surface in the septic system drainfield. The analysis results revealed low levels of TCE, ranging from 0.20 to 9.72 ppb. The BCM report concluded that the septic system drainfield was likely not a source of ground water contamination. A final report, dated 3 March 1981, represents BCM's conclusion of the Phase I and Phase II investigation.

By a mutual agreement between the PADER and Transicoil, a revised Phase III investigation was initiated during the summer of 1981. The Phase III investigation consisted of the collection of monthly ground water samples of Transicoil's production wells #3 and #6, and analysis of these samples by BCM's laboratory for TCE, PCE, and 1,1,1-TCA. The sampling was to continue for a 3 to 6 month period.

Upon completion of the 6 month sampling, BCM concluded that the concentrations of TCE, PCE, and 1,1,1-TCA were substantially less than those observed in 1979. The PADER and Transicoil agreed to monitor wells #3 and #6 for an additional 6 month period on a quarterly sampling frequency. The results of the second quarterly sampling of this effort indicated the concentrations of TCE and 1,1,1-TCA in wells #3 and #6 to be less than 50 ppb. Based on the results of the sampling, the ground water monitoring was discontinued.

2.2.3 SMC Martin, Report of 1988 (Soil Gas Survey)

In April of 1988, SMC Martin, Incorporated was retained by Transicoil to perform a soil gas survey of the Transicoil site. The objectives of the soil gas survey were to delineate possible source areas at the Transicoil site, and identify the potential for contaminant movement from the Transicoil site and the direction of such contaminant movement, if identified.

The field investigation consisted of soil gas sampling at 36 sampling points in areas north, northwest, and northeast of the main Transicoil processing building. Samples were also collected in the vicinity of well T-6, around the drum storage areas and adjacent to Building #2. Samples were obtained from approximately 3 feet below the ground surface. The soil gas samples were screened with both a flame ionization detector (FID) and a photoionization detector (PID). Additionally, a portable gas chromatograph was used for analysis for the two compounds, TCE and 1,1,1-TCA. Of the 36 sampling points, only one was reportedly located in the septic drain field.

The results of the soil gas survey showed several areas of elevated total VOC concentration, mainly in the vicinity of

Building 2 and in the vicinity of drum storage areas. However, only two of the soil gas sampling points showed detectable levels of TCE and 1,1,1-TCA. The SMC Martin report concluded that the soil gas survey did not delineate any contaminant source areas or movement of contaminants from the site through ground water. SMC Martin recommended the installation of several monitoring wells to the north of the property to verify the presence or absence of contaminants migrating from the site.

2.2.4 ERM Hydrogeologic Study of July-August 1988

During the summer of 1988, Environmental Resources Management, Inc. (ERM), conducted a hydrogeologic investigation at the Worcester site for Transcoil, Inc. While the results of that study were never published, information learned from that study is incorporated into this Work Plan. That investigation involved the following work:

- a review of existing water quality data;
- a fracture trace analysis;
- the installation of six ground water monitoring wells;
- analysis of ground water samples collected from those six wells and also from one inactive and five active production wells; and
- measurement of water levels in the six newly installed monitoring wells and the inactive production well.

TCE was the principal compound detected beneath the site, with 1,1,1 TCA, dichloroethylene and a chloroflorohydro carbon (CFC) compound also present. The TCE concentrations in shallow ground water defined an east-west trending plume, centered beneath the Transcoil property. The highest levels of TCE occurred in monitoring wells MW-1 and MW-2, located just downgradient of Transcoil's septic drain field. The highest concentration of CFC was found in shallow production well T-5. The deeper wells at the site contained low concentrations of VOCs, compared to the shallow wells.

Hydraulic gradients as measured in the monitoring wells indicated that the direction of ground water flow beneath the site is affected by pumping of local production wells and by recharge at the Transcoil septic drainfield. In the area of the septic drainfield, hydraulic loading locally mounds the water table, causing ground water to flow radially away from the drainfield. Mounding is limited in the regional ground water

system, with the bulk of the gradient being to the northwest. The results of ERM's investigation indicated that pumping of the Transicoil and Rehab Center production wells has drawn VOCs laterally along the ridgetop, parallel to bedrock strike in the shallow aquifer. The degree of contribution from the Transicoil site vs. the Nike Site is unknown at this time. This condition is consistent with ERM's experience in other areas within the Triassic Basin aquifers.

2.3 Site Description

2.3.1 Hydrogeologic Setting

The Transicoil, Inc. property sits at approximately 480 feet above mean sea level (MSL), along the crest of a broad east-west trending ridge in the Triassic Lowlands physiographic section. The property lies within the outcrop belt of the Triassic age Lockatong and Brunswick formations. The Lockatong and Brunswick formations consist of interbedded reddish-brown, silty shale and shaley siltstone, with some beds of dark grey and dark green shale. These formations strike approximately east-west and dip to the north-northwest at 10 to 20 degrees. Most of the study area is underlain by the Lockatong Formation, which consists primarily of thick-bedded gray argillite.

Ground water in the Lockatong Formation flows through fractures, and bedding planes. Under the influence of pumping, cones of depression tend to form preferentially along bedrock strike or fracture orientation. Ground water within the bedrock beneath ridges in the area generally occurs at depths of several tens of feet below the ground surface. During wet seasons, perched water tables may exist at the soil/bedrock interface. At the site, the direction of ground water flow is likely to be to the north-northwest, generally parallel to the structural dip of the bedrock and down the topographic gradient. On the south side of the ridge, a southward flow component may occur under topographic influence. As will be shown below, influences such as hydraulic loading at the surface, fracture and bedding patterns, and pumping of production wells may locally redirect the prevailing direction of ground water flow.

2.3.2 Ground Water Quality

In August 1988 ERM collected samples of ground water from twelve ground water wells at the site: monitoring wells MW-1 through MW-6; the abandoned Worcester Nike Park Production Well; Transicoil's three production wells (T-3, T-5, and T-6); the production well at the Center Point Training Center (Rehab

Center well); and the production well at the U.S. Army Reserve Base (Reserve Base well). All production well samples were collected from the closest available tap. It should be noted that water collected from the Reserve Base production well is chlorinated for disinfection. Figure 2-2 shows the locations of ground water monitoring and production wells, and features identified as probable fracture traces in the vicinity of the Worcester Site. Table 2-1 presents the monitoring wells at the site and known construction details for active and inactive production wells.

Table 2-2 presents the analytical results of the ground water samples collected from the wells at the site. Figure 2-3 shows that the total concentration of chlorinated ethenes (TCE and breakdown products, 1,1-dichloroethene, and 1,2-dichloroethene) in shallow ground water beneath the site defines an east-west trending plume that parallels the structural strike of the subsurface bedrock. This plume configuration is consistent with the expected effects of the cyclical pumping of the Transicoil and Rehab Center wells.

The highest concentrations of chlorinated ethenes occur in monitoring wells MW-1 and MW-2 downgradient of the septic drain field at the Transicoil, Inc. facility. The data indicate that the concentrations of these constituents decreases to the southeast and east of the drain field. Figure 2-4 shows the total ethene concentration plume in the deeper part of the aquifer, likely pulled down from above by the pumping of the production wells over time.

Figures 2-5 and 2-6 indicate that the concentrations of chlorinated ethanes (1,1,1-trichloroethane and 1,1-dichloroethane) in ground water beneath the site are considerably less than that of chlorinated ethenes. Again, the shallow plume defined by the chlorinated ethanes also parallels the east-west structural strike of the bedrock, with an elongate high running from MW-1 (72 ug/L) through T-6 (63 ug/L) to MW-4 (150 ug/L) near the Rehab Well. The available wells indicate plume movement generally northeast, and south of this elongate high, where the chlorinated ethanes decrease to low concentrations.

Figures 2-7 and 2-8 show the estimated concentrations of total CFC in ground water beneath the site. The plume defined by CFC in shallow ground water is centered at Transicoil production well T-5. The plume extends to the north, northeast, and northwest of the site; however, the boundaries of

Table 2-1
Well Construction Data
Transicoil, Inc.

Well ID	Depth in feet below grade	Ground Surface Elevation in feet msl	Top of Casing Elevation in feet msl	Open Interval Length feet
MW-1	122	471.95	474.18	102
MW-2	110	467.23	469.67	87
MW-3	160	462.59	464.42	140
MW-4	110	456.69	458.54	76
MW-5	160	461.58	464.44	130
MW-6	90	463.64	466.21	70
Worcester Nike Park Prod. Well	?	456.79	457.85	
T-3	308	?	?	
T-5	137	?	?	
T-6	913	?	?	
Rehab Center Prod. Well	?	?	?	
Reserve Base Prod. Well	~200	?	?	

? Data not available

Table 2-2
Analytical Results of Ground Water Samples
(All results in ug/l)

ENM Traffic # Sample Location	11409 T-3	11410 T-5	11411 T-6	11422 MW-1	11421 MW-2	11415 MW-3	11416 MW-4	11418 MW-5	11414 MW-6	11419 Worcester Nike Park Well	11420 Rehab Center Tap	11413 Reserve Base Well
Date Sampled	8/23/88	8/23/88	8/23/88	8/25/88	8/25/88	8/24/88	8/24/88	8/25/88	8/24/88	8/25/88	8/25/88	8/24/88
Volatile Organic Compounds:												
1,1-dichloroethene			6	11			7					
1,1-dichloroethane			5	25	20							
1,2-dichloroethene (total)				16	14					27	43	
1,1,1-trichloroethane	12	20	58	47	16	16	150					6
bromodichloromethane												
trichloroethene	9	12	33	940	500	98	34			17	32	
Volatile Tentatively Identified Compounds:												
Freons -												
ethane, 1,1,2-trichloro-												
ethane, 1,2-dichloro-	68 J	650 J	54 J	180 J	82 J	35 J	79 J			50 J		
ethane, 1,1,2-trifluoro				63 J								

**PRELIMINARY
DATA**

Checked by S. Sayko 8/31/89
DATA ENTERED DATE
Reviewed by David R. Blye 9-27-89
DATA REVIEWED DATE

Qualiter Codes.
 J: This result should be considered a qualitative estimate.
 Blank spaces indicate that the compound was not detected

R0000887

Notes:

Checked by / Date: S Sayko 8/31/89

Drawn by / Date: D.L. 8/31/89

Checked by / Date:



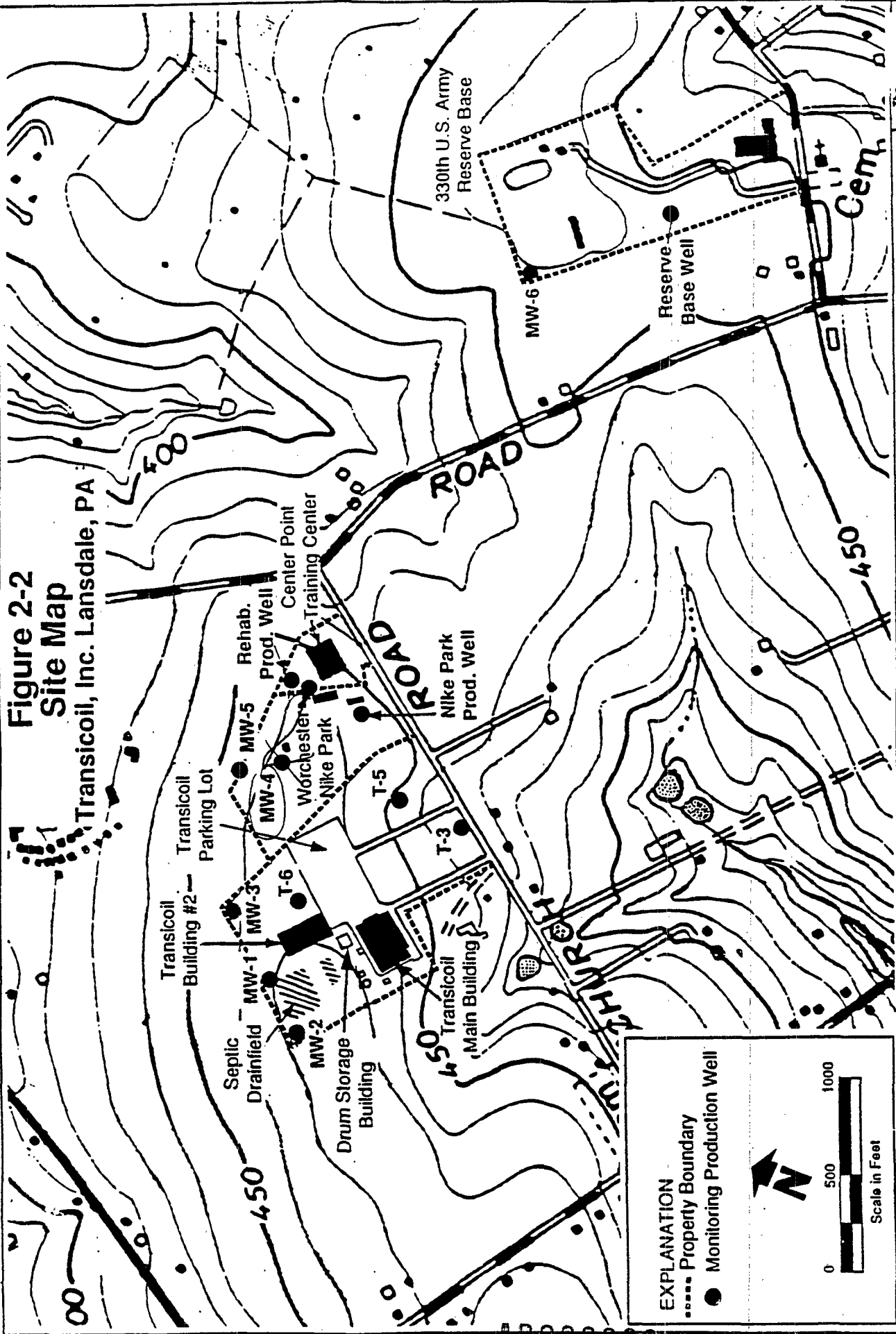

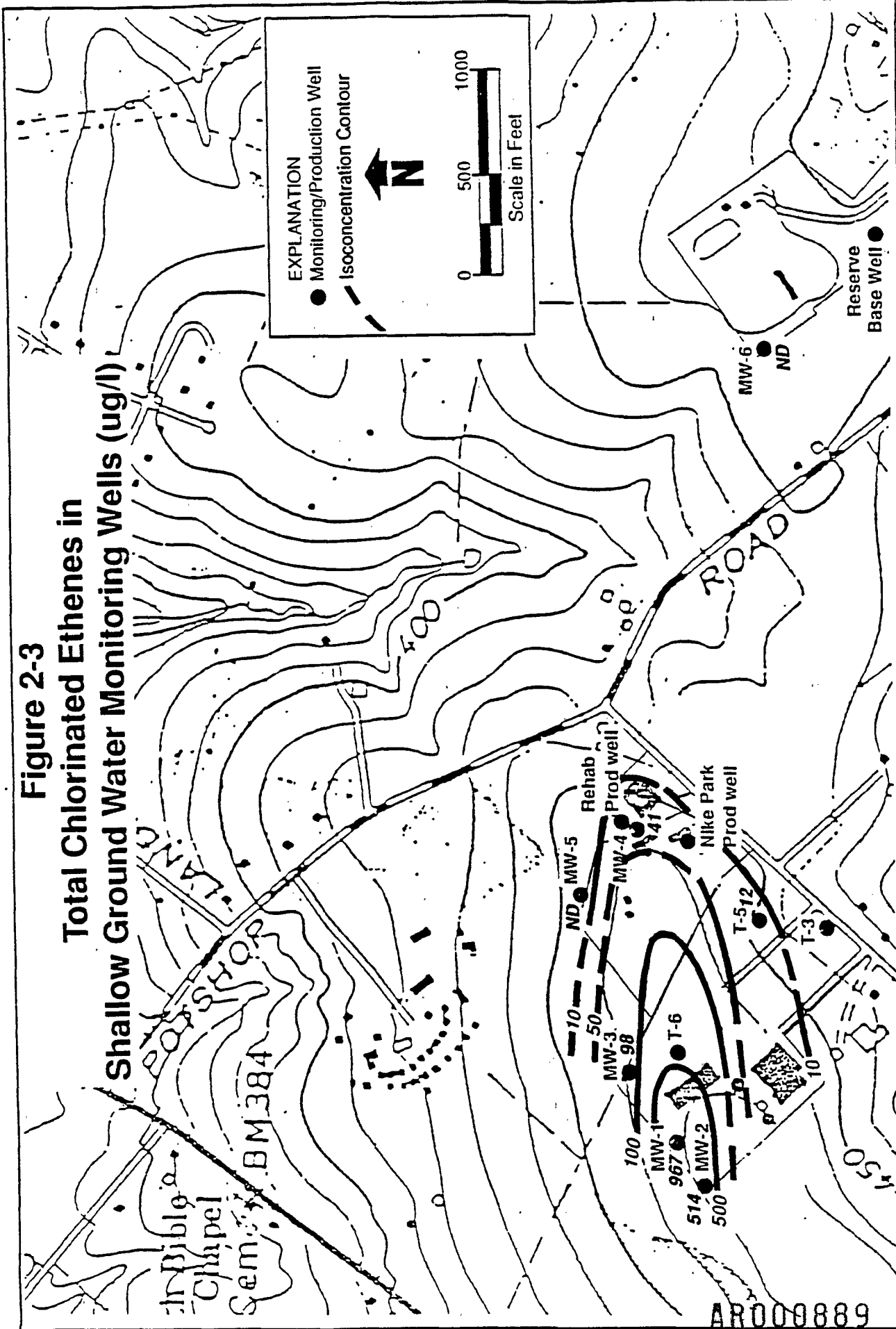


Figure 2-2
Site Map
Transcoil, Inc. Lansdale, PA

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	Revised by / Date: D. Grabowski 5/18/90	Checked by / Date: B. Richardson 5/18/90	

AR000888

Figure 2-3
Total Chlorinated Ethenes in
Shallow Ground Water Monitoring Wells (ug/l)



AR000889

Notes:

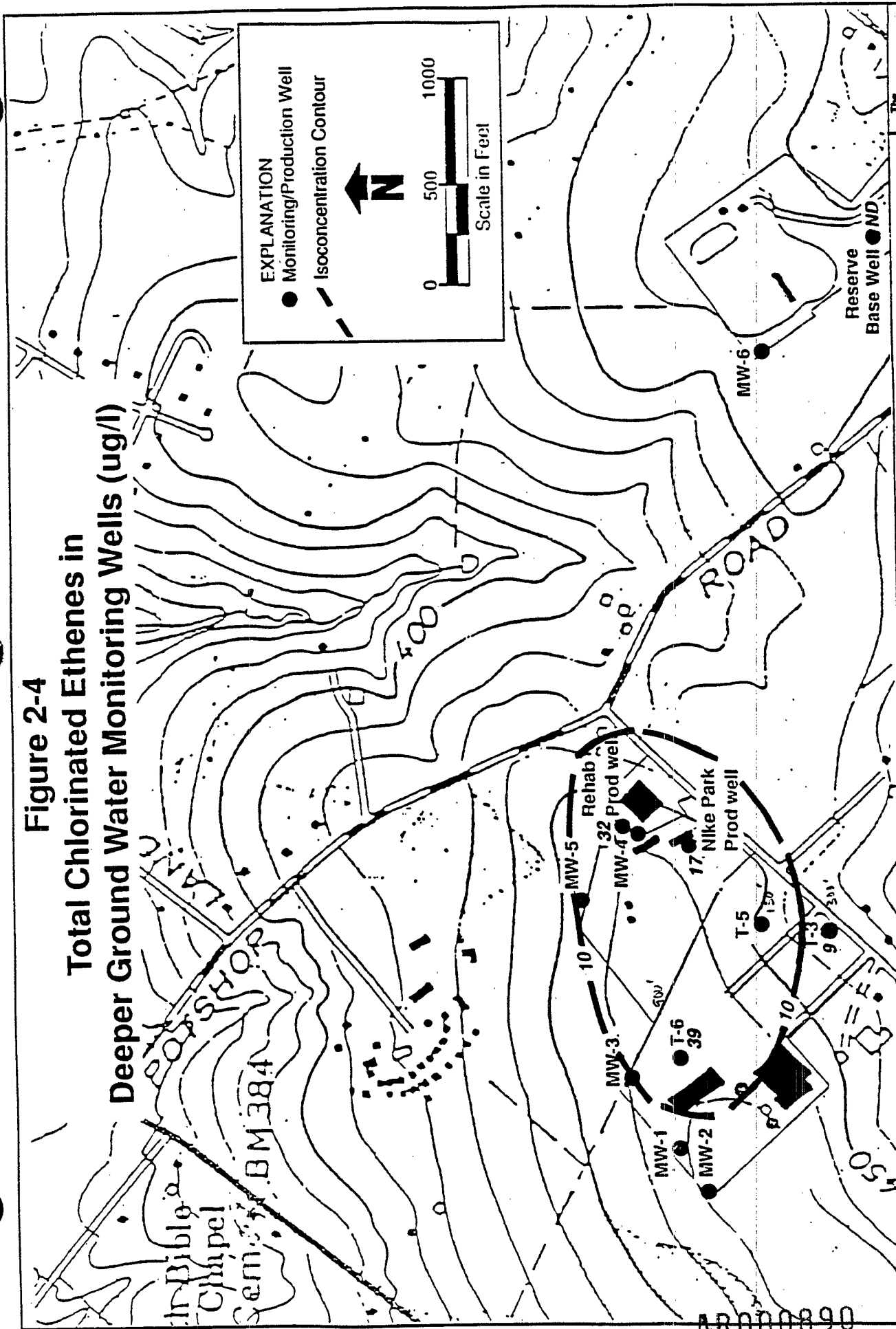
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7510

Figure 2-4
Total Chlorinated Ethenes in
Deeper Ground Water Monitoring Wells (ug/l)



Notes:

Checked by / Date: S. Sayko 8/31/89

Drawn by / Date: D.L. 8/31/89

Checked by / Date:

Revised by / Date: D. Grabowski 2/5/90

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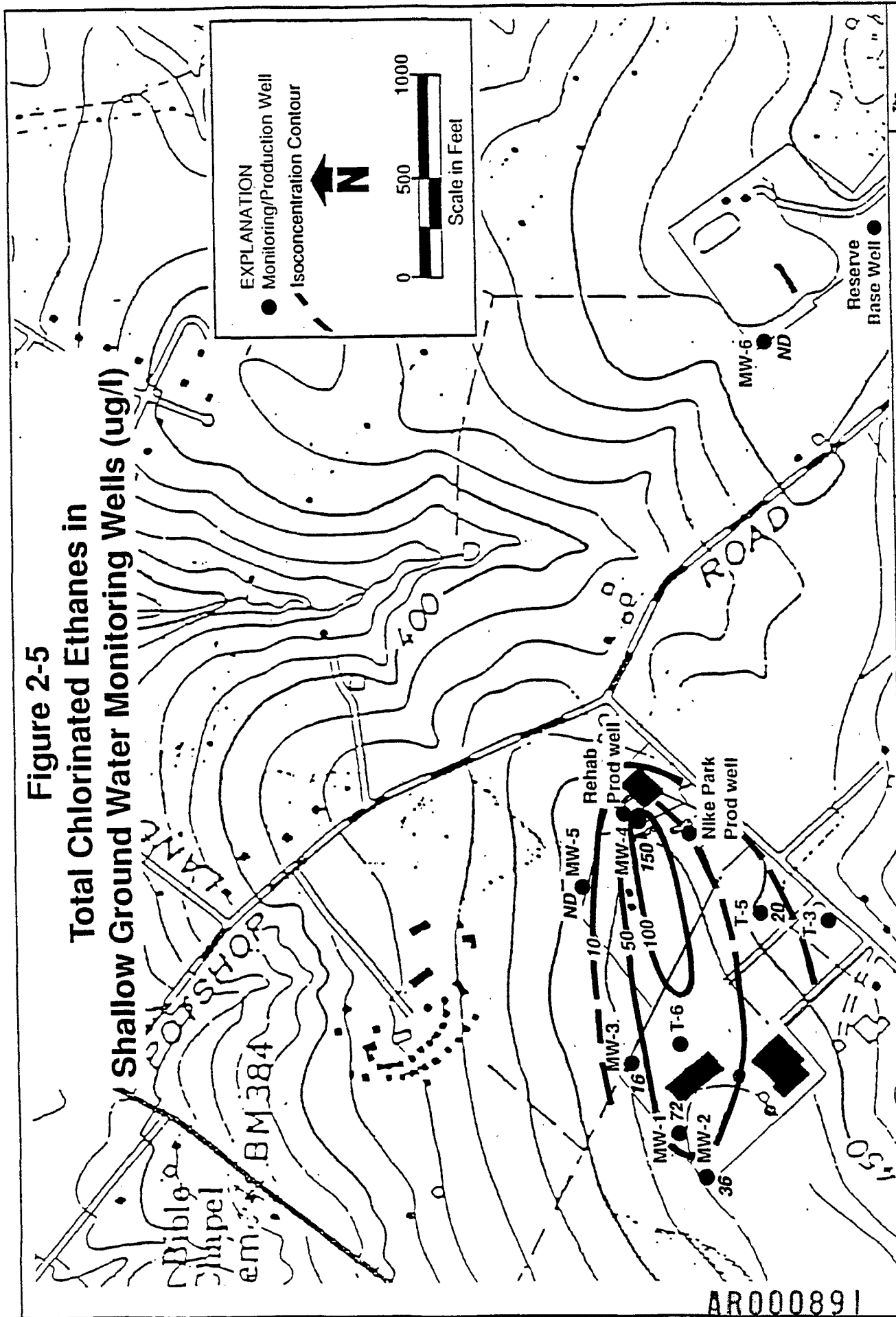
THE ERM Group

AR0000890

Figure 2-5

Total Chlorinated Ethanes in

Shallow Ground Water Monitoring Wells (ug/l)



AR000891

Notes:

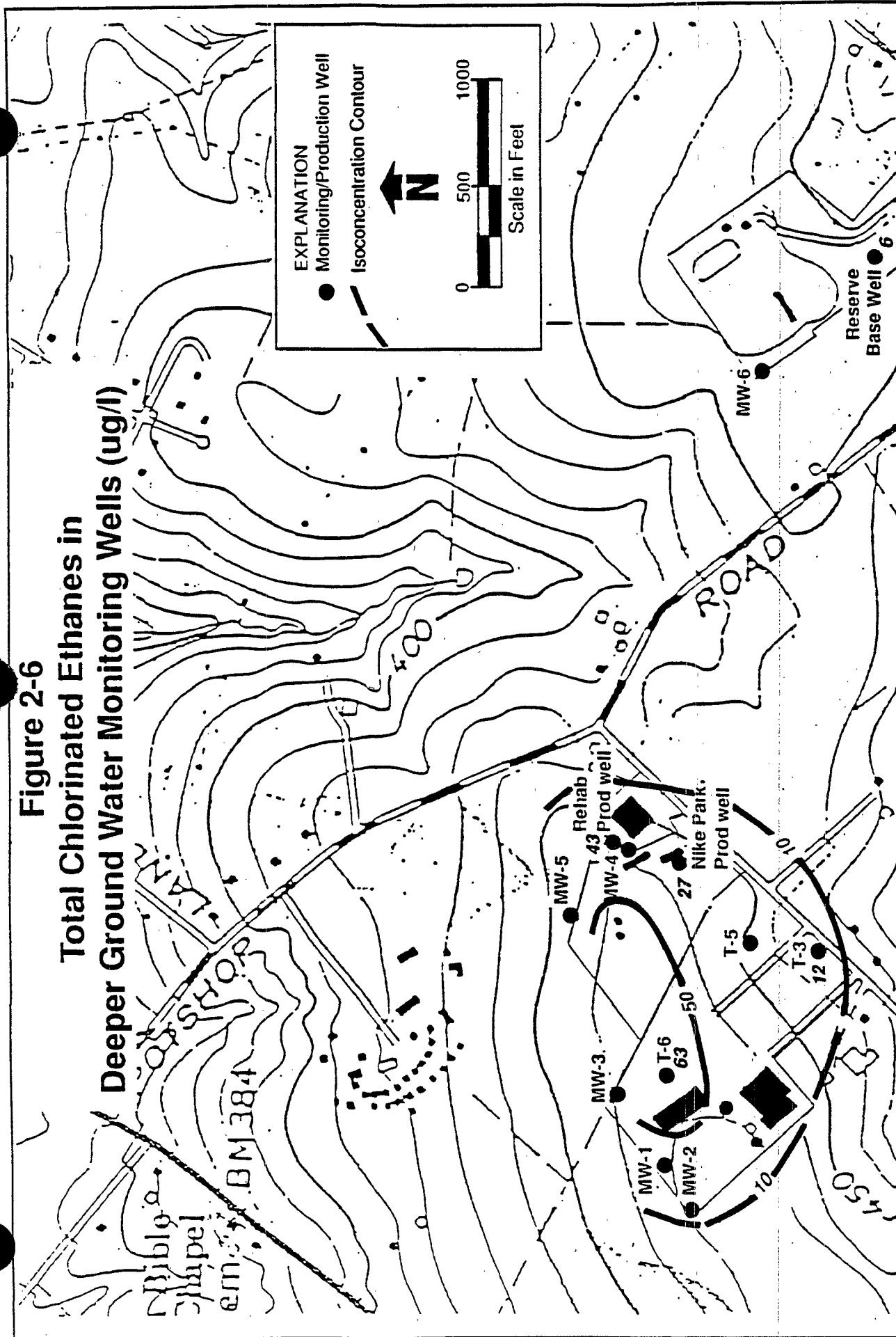
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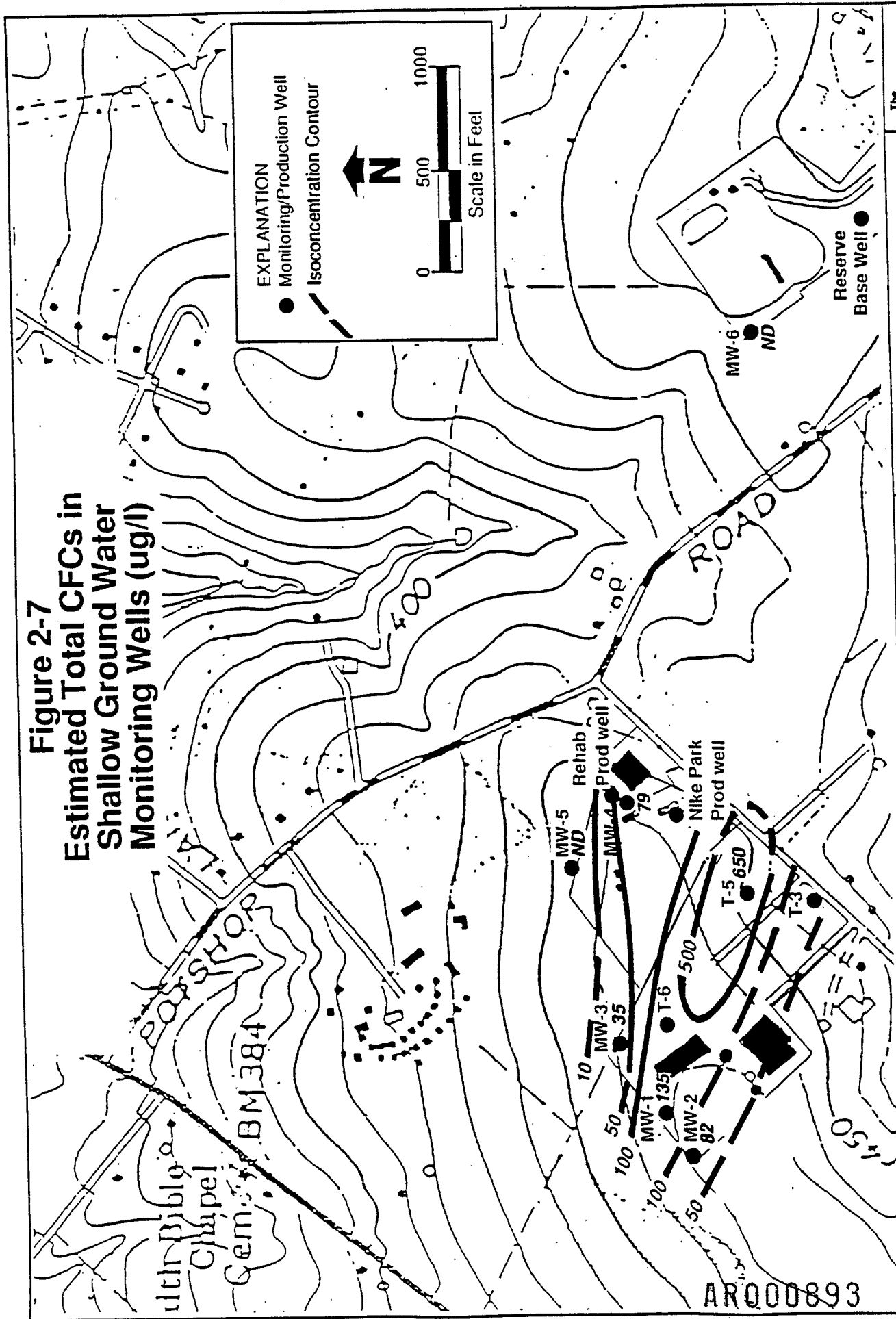
The STRM

Figure 2-6
Total Chlorinated Ethanes in
Deeper Ground Water Monitoring Wells (ug/l)



<p>WOF 75101</p>	<p>Drawn by / Date: D.L. 8/31/89</p> <p>Revised by / Date: D. Grabowski 2/5/90</p>	<p>Checked by / Date: S. Sayko 8/31/89</p>	<p>Notes:</p>
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Figure 2-7
Estimated Total CFCs in
Shallow Ground Water
Monitoring Wells (ug/l)



Notes:

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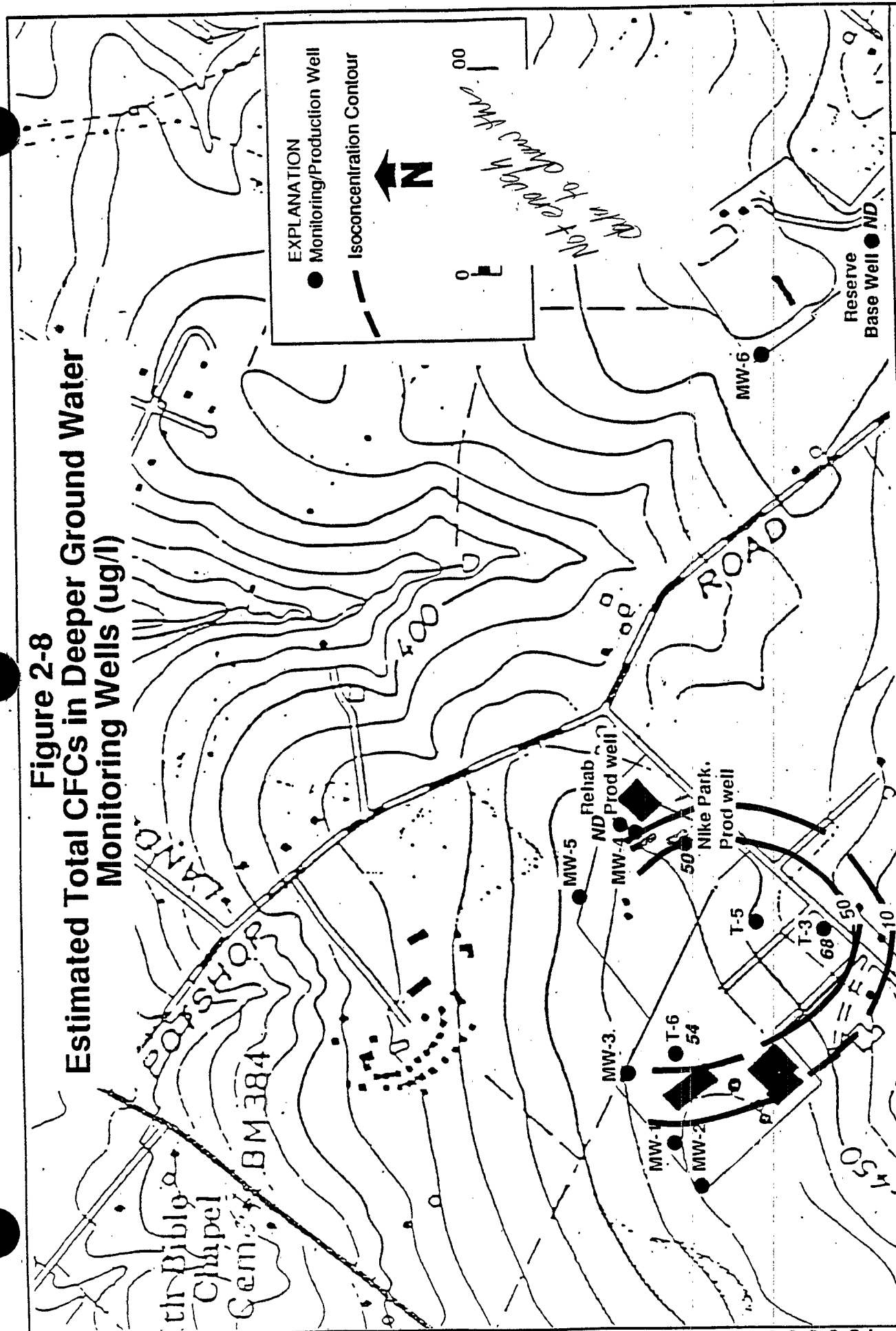
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W07

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Figure 2-8
Estimated Total CFCs in Deeper Ground Water
Monitoring Wells (ug/l)



Notes:

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			Revised by / Date:	D. Grabowski 5/18/90	Checked by / Date:	B. Richardson 5/18/90



AR000894

the plume remain undefined, especially south and east of production well T-5.

Ground water from monitoring well MW-6 located on the U.S. Army Reserve base contained no chlorinated ethenes, ethanes, or CFC which were found in the other wells above their respective detection limits. The Reserve Base production well contained only one volatile organic compound, bromodichloromethane, at 6 ug/l. As bromodichloromethane is a common by-product of the chlorination process of potable water, its presence in the Reserve Base well likely reflects the chlorination of ground water at the holding tank.

2.3.3. Ground Water Flow Dynamics and Directions

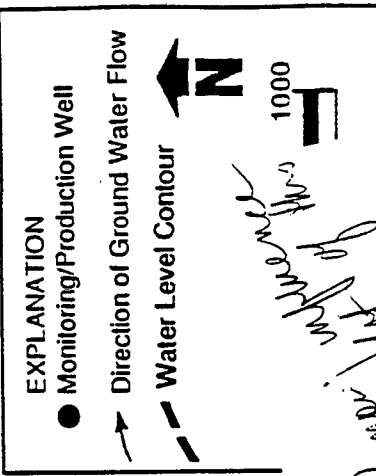
ERM collected depth to water measurements in the six monitoring wells and the abandoned Worcester Nike Park production well on three separate occasions: 18 August 1988, 23-25 August 1988, and 26 September 1988. Since the remaining five wells at the site are active production wells, the water levels in them could not be measured accurately due to access problems.

As shown on Table 2-3, repeated measurements on 26 September indicated that Monitoring well MW-4, located approximately 40 feet southwest of the Rehab Center production well, showed a wide range of water levels, indicating a change in head of at least 6.2 feet in as little as 2 hours. Monitoring well MW-5 to the northwest showed a slight decrease in head between the first and second water level measurements. Monitoring wells MW-1, MW-2, and MW-3 showed no change in head between the first and second water level measurements on that date. During the time of these measurements, the Rehab Center well cycled on and off, fulfilling the Center's morning water needs. Also, it is reported that Transicoil's Well T-5 was pumping during that period.

The dramatic drawdown in MW-4 in response to pumping supports the interpretation that ground water occurrence and flow beneath the site is strongly influenced by geologic features, as that well is located along strike from the Rehab Center well, and close to along strike from Well T-5. The lesser water level change in MW-5 may also be related to pumping in the Rehab Well or pumping in Transicoil's production wells.

Figure 2-9 depicts the potentiometric ground water contours beneath the site during 23-25 August 1988. Ground water beneath the site flows generally north, parallel to the bedrock dip and down the topographic gradient; however, an area of high

Figure 2-9



Checked by / Date: S Sayko 8/31/89

Drawn by / Date: D.L. 8/31/89

Revised by / Date: D. Grabowski 2/5/90

The ERM

~~AR000896~~

Table 2-3
Water Level Elevations
In Feet Above MSL

Monitoring Well	8/18/88	8/23-25/88	Initial	9/26/88	Later Rounds
MW-1	410.68	410.18	408.58	408.58	~ 60' below grade
MW-2	401.87	401.07	399.77	399.77	~ 67' "
MW-3	405.12	404.62	402.92	402.92	~ 59' "
MW-4	396.84	397.24	400.94	394.74-400.44	~ 60' "
MW-5	Recovering	401.04	403.24	402.04	~ 60' "
MW-6	Recovering	401.31	400.11	not measured	~ 58' "
Worcester Nike Production Well	402.55	403.55	Casing collapsed at 410		

Notes:

Drawn by / Date: D.L. 8/31/89

Checked by / Date: S Sayko 8/31/89

Revised by / Date:

Checked by / Date:

hydraulic head occurs near the septic system drain field, which creates ground water gradients radially west, north, and northeast from the drain field. The area of high head beneath the drain field apparently results from recharge in the drain field locally raised the water level in the aquifer. It is not known at what distance from the drain field the prevailing northward gradient in the aquifer overcomes the local recharge effect.

The map shows the depression of the water level elevation in monitoring well MW-4 and its proximity to the Rehab Center production well. It should be noted that the depth of the Nike Park well is unknown, and the ground water elevations shown may or may not reflect the shallow aquifer condition.

The effect of Transcoil's production wells is not evident; however, their pumping status (on or off) is not known during the water level measurement event. Well T-6 is over 900 feet deep, and may not exert a strong influence on the shallow aquifer if it produces from very deep water bearing zones. However, well T-5 is shallow (137 feet) and is likely to have a greater influence on the movement of shallow ground water at the site.

2.3.4 Probable Source Areas

Source areas as discussed herein refers to areas on the Transcoil site which contribute VOCs to ground water as the result of direct contact with site-related contaminants. The concerns associated with source areas are that infiltration of precipitation through these soils might result in continuing degradation of ground water quality. A secondary concern might be the potential for physical contact with these soils, although the volatile nature of the site-related compounds renders their presence in surface soils very unlikely.

At least one potentially continuing source area has been identified from previous investigations at the site, e.g., the septic drain field. From the distribution of VOCs in ground water, the septic drain field appears to have been the source of TCE and 1,1,1 TCA contamination in the site ground water.

To date, soil investigations in the area covering much of the property west of the main building and parking area, including the drum storage area have failed to identify any source areas.

Additional potential source areas for investigation will be determined from a review of historical aerial photos, employee interviews and from the Site Analysis report prepared for EPA by Bionetics, Corp. Areas identified in the Site Analysis report for

further consideration include: past tank locations, stained soil, debris, possible drum storage areas, fill area, and mounded material. Any areas identified by employees as potential spill locations or any stained areas or areas of stressed vegetation observed during the site walkover will also be considered.

2.3.5 Probable Affected Receptors

The potential receptors for site-related contamination include the human population and the sensitive environmental areas (i.e. wetlands, etc.) within one-half mile of the site. Our review of the files and conversations with knowledgeable state, local and federal officials suggest that no sensitive environmental areas exist within this one-half mile range. The only potential human exposures deemed likely to require evaluation are related to site-related effects on downgradient potable water supplies from domestic wells.

2.4 Identification of Data Gaps

2.4.1 On-Site

As discussed previously, several studies have been performed on the Transicoil property since 1979. These studies have focused on various portions of the site. They have demonstrated the presence of site-related VOCs in the ground water and on-site soils. Review of the existing database has revealed the following data gaps critical to completion of the RI/FS for the site:

- ✓ • definition of the vertical and horizontal extent of VOC migration in ground water;
- ✓ • definition of areas of soil which might be significant continuing sources of VOCs to the ground water; and
- ✓ • definition of ground water flow dynamics and their effect on contaminant migration.

Based on the above needs, this investigation is designed to more completely define the horizontal and vertical distribution of site related contaminants in ground water, and to define ground water flow dynamics. The hydrogeologic investigation described in Section 3 will be sufficient to evaluate the distribution of VOCs in the ground water to determine the potential for site-related risks due to ground water contamination, and to complete an evaluation of remedial alternatives for ground water in the FS.

Although previous studies have attempted to assess the distribution of VOCs in on-site soils, this study will be more detailed in scope and will look at the site as a whole. So far,

studies to date have identified only the septic field as an area of potential concern with respect to soil contamination. Areas which remain to be investigated include but are not limited to:

- a former drum storage area located in the northeast corner of the site;
- the far end of the parking lot where drums of scrap materials formerly were stored.

Other areas for study may be identified after a detailed review of aerial photography and site reconnaissance.

2.4.2 Off-Site

The residents in the area surrounding the Transicoil site depend on private ground water wells as a water supply. Few analyses have been conducted at these wells, and none recently enough to estimate existing conditions. At least two commercial wells in the vicinity of the site, at the Rehab Center and at the Army Engineering base, are in use. These wells were sampled in 1988, with results showing a concentration of 75 ppb of total VOCs in the Rehab center. No VOCs of potential concern were detected in the Army well sample. Water quality in the residential wells downgradient of the site represents a data gap that must be filled to determine if VOCs are present in those wells and, if present, at what concentrations.

Appendix B
FSP Standard Operating Procedures

AR000901

SOP 1: Decontamination

I. PURPOSE

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

II. SCOPE

This is a general description of decontamination procedures.

III. EQUIPMENT AND MATERIALS

- Demonstrated analyte-free, deionized ("DI") water
- Distilled water
- Potable water (must be from a municipal water supplier, otherwise a priority pollutant +40 analysis must be run)
- 2.5% (W/W) trisodium phosphate ("TSP") and water solution
- Concentrated (V/V) pesticide grade methanol and hexane (DO NOT USE ACETONE)
- 10% (V/V) nitric acid (HNO_3) and water solution (only ultrapure grade HNO_3 is to be used)
- Large plastic pails or tubs for TSP and water, scrub brushes, squirt bottles for TSP, methanol and water, plastic bags and sheets
- DOT approved 55-gallon drum for disposal of waste
- Phthalate-free gloves
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

IV. PROCEDURES AND GUIDELINES

A. PERSONNEL DECONTAMINATION

To be performed after completion of tasks whenever potential for contamination exists, and upon leaving the exclusion zone.

1. Wash boots in TSP solution, then rinse with water. If disposable latex booties are worn over boots in the work area, rinse with TSP solution, remove, and discard into DOT approved 55-gallon drum.
2. Wash outer gloves in TSP solution, rinse, remove, and discard into DOT approved 55-gallon drum.
3. Remove disposable coveralls ("Tyveks") and discard into approved 55-gallon drum.
4. Remove respirator (if worn).
5. Remove inner gloves and discard.
6. At the end of the work day, shower entire body, including hair, either at the work site or at home.
7. Sanitize respirator if worn.

B. SAMPLING EQUIPMENT DECONTAMINATION

Reuseable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Prior to entering the potentially contaminated zone, wrap soil contact points in aluminum foil (shiny side out).
3. Rinse and scrub with potable water.
4. Wash all equipment surfaces that contacted the potentially contaminated soil/water with TSP solution.
5. Rinse with potable water.
6. Rinse with 10% HNO_3 solution when sampling for inorganics (carbon split spoons will be rinsed with a 1% solution and rinse).

7. Rinse with distilled or potable water methanol solution (DO NOT USE ACETONE). Rinse again using hexane if sampling for organics.
8. Air dry.
9. Rinse with deionized water.
10. Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately.
11. Collect all rinsate and dispose of in a DOT approved 55-gallon drum.

C. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with TSP solution, then a towel wet with methanol solution, and finally three times with a towel wet with distilled water. Dispose of all used paper towels in a DOT approved 55-gallon drum.

D. SAMPLE CONTAINER DECONTAMINATION

The outsides of sample bottles or containers filled in the field must be decontaminated before being packed for shipment or handled by personnel without hand protection.

1. Wipe container with a paper towel dampened with TSP solution or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.
2. Dispose of all used paper towels in a DOT approved 55-gallon drum.

E. HEAVY EQUIPMENT AND TOOLS

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated upon arrival at the site and between locations as follows:

1. Set up a decontamination pad in area designated by EPA
2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

V. ATTACHMENTS

None.

VI. KEY CHECKS AND ITEMS

- Clean with solutions of TSP, methanol (or isopropanol) and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

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SOP 2: Soil Boring Drilling and Abandonment

I. PURPOSE AND SCOPE

The purpose of this guideline is to describe methods to obtain samples of subsurface soil and then backfill boreholes to the surface.

II. EQUIPMENT AND MATERIALS

- Drilling rig, tripod rig, or hydraulic probe sampler
- Hollow-stem augers (4 1/4-inch ID)
- Split-spoon samplers
- Downhole compacting tool (e.g., a pipe with a flat plate attached to the bottom)
- Cement
- Bentonite
- Hand augers, stainless steel

III. PROCEDURES AND GUIDELINES

Before sampling begins, equipment will be decontaminated according to the procedures identified in SOP 1: Decontamination. The location to be sampled is cleared of debris and trash, and the location is noted in the logbook.

Hydraulic Probe sampling will be used to collect soil samples. The use of water or other fluid to assist in drilling will be avoided.

The bit of the soil probe is placed on the ground at the location to be drilled and then pushed with the drilling or soil-coring rig.

Once the probe has been advanced full depth and the last sample obtained, the soils removed from the boring and the extra sample will be drummed. The borehole is to be grouted to the surface with bentonite-cement grout. The remaining soils are to be drummed and managed as described in SOP 17.

The cement-bentonite grout will be installed continuously in one operation to ground surface.

Samples will be collected from the soil borings at 2-foot intervals. The soil samples will be collected from the surface continuously to bedrock. Because some of the soil samples are being collected for chemical analysis, decontaminated stainless steel samplers will be used for sample collection. The samplers will be decontaminated according to the procedures outlined in SOP 1. Sample collection will follow the general procedures outlined in SOP 3.

IV. ATTACHMENTS

None.

V. KEY CHECKS AND PREVENTATIVE MAINTENANCE

Check that the drilling rig or soil-coring rig is in working order. Check that the borehole is grouted to the ground surface at the completion of drilling and sampling.

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SOP 3: Soil Sampling

I. PURPOSE AND SCOPE

The purpose of this procedure is to provide guidelines for obtaining samples of surface and subsurface soils using hand and drilling-rig mounted equipment.

II. EQUIPMENT AND MATERIALS

- Stainless-steel trowel, shovel, scoopula, coring device, trier, hand auger, or other appropriate hand tool
- Stainless-steel, split-spoon samplers, or hydraulic probe sampler
- Thin-walled samplers (e.g., Shelby tubes)
- Drilling rig or soil-coring rig
- Stainless-steel pan or bowl
- Scoopula or other appropriate hand tool
- Sample bottles

III. PROCEDURES AND GUIDELINES

A. Surface Sampling

Before sampling begins, equipment will be decontaminated using the procedures described in SOP 1: Decontamination of Drilling Rigs and Equipment. The sampling point is located and recorded in the field logbook. Debris should be cleared from the sampling location.

A shovel, post-hole digger, or other tool can be used to remove soil to a point just above the interval to be sampled. A decontaminated sampling tool will be used to collect the sample when the desired sampling depth has been reached. The sampling tool should be stainless steel and decontaminated in accordance with the procedures outlined in SOP 1. Soil for semivolatile organic and inorganic analyses is placed in the bowl and mixed; soil for volatile organic analysis is not mixed or composited but is placed directly into the appropriate sample bottles. A stainless-steel or dedicated wooden tongue depressor is used to transfer the sample from the bowl to the container.

The soils removed from the borehole should be visually described in the field log book, including approximated depths.

When sampling is completed, flame ionization device (FID) readings should be taken directly above the hole, and the hole is then backfilled. After sampling the collected samples are labeled and handled as described in the FSP.

B. Split-Spoon Sampling

By use of a drilling rig at other soil boring locations, a hole is advanced to the desired depth. For split-spoon sampling, the samples are then collected following the ASTM D 1586 standard (attached). The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically this is 24 inches. The sampler is driven in 6-inch increments using a 140-pound weight ("hammer") dropped from a height of 30 inches. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch ID sampler may be required. Blow counts obtained with a 3-inch ID spoon would not conform to ASTM D 1586 and would therefore not be used for geotechnical evaluations. The number of hammer blows for each 6-inch interval is counted and recorded.

Once retrieved from the hole, the sampler is carefully split open. Care should be taken not to allow material in the sampler to fall out of the open end of the sampler. To collect the sample, the surface of the sample should be removed with a clean tool and disposed of. Samples collected for volatiles analysis should be placed directly into the sample containers from the desired depth in the split spoon. Material for collection of samples for all other parameters should be removed to a decontaminated stainless steel tray. The sample for non-volatiles analysis should be homogenized in the field by breaking the sample into small pieces, and removing gravel. The homogenized sample should be placed in the sample containers. If sample volume requirements are not met by a single sample collection, additional sample may be collected by collecting a sample from below the sample, and compositing the sample for non-volatile parameters only.

Split-spoon samples also will be collected using a tripod rig. When using a tripod rig the soil samples are collected using an assembly similar to that used with the drilling rigs.

C. Shelby Tube Sampling

Thin-walled samplers are advanced hydraulically by continuous pressure from a drilling rig. ASTM D 1587 is the standard for this method. At the end of the designated push interval and before lifting the sample, the sampler is twisted to break the bottom of the sample.

Upon recovery of the sampler, the actual length of the sample is measured and recorded, excluding slough or cuttings. At least 1/2-inch of soil is cleaned from each end of the sampler. The soil that has been cleaned from the sample can be used for visual classification.

Each end of the sampler is waxed. After the initial sealing, a filler (e.g., paper or sand) can be placed in the remaining open area of the sampler to avoid breaking of the initial end seals. The ends of the sampler are then closed with tight-fitting metal or plastic caps, and the seam between the cap and sampler is taped. The ends of the sampler may be dipped in hot wax to completely cover the tape and seal the sampler. The sample and the top cap are labeled with appropriate information, including the designation of the boring, the date and time of sampling, the sample number, and pertinent information about the collection of the sample. The side of the sampler is marked as to which end is the top and which is the bottom. The sampler should be carried gently and kept in an upright, vertical position as much as possible to maintain the in situ orientation and to minimize sample disaggregation.

D. Hydraulic Probe Sampling

Hydraulic probe samplers are advanced hydraulically by continuous pressure from a sampling rig. Upon recovery of the sampler, the actual length of the sample is measured and recorded. The sample is then visually classified. The surface of the sample should be removed with a clean tool and disposed of. Samples collected for volatiles analysis should be placed directly into the sample containers from the desired depth in the sample. Care should be taken to fill the sample jar completely leaving no open spaces. Material for collection of samples for all other parameters should be removed to a decontaminated stainless steel tray. The sample for non-volatiles should be homogenized in the field by breaking the sample into small pieces, and removing gravel. The homogenized sample should be placed in the sample containers. If sample volume requirements are not met by a single sample collection, additional sample may be collected by collecting a sample from below the sample, and compositing the sample for non-volatile parameters only.

IV. ATTACHMENTS

None

V. KEY CHECKS AND PREVENTATIVE MAINTENANCE

Check that decontamination of equipment is thorough. Check that sample collection is swift to avoid loss of volatile organics during sampling. When collecting samples using thin-walled samplers, check that the pressure is applied smoothly and continuously, not in a jolting fashion.

SOP 4: Soil Characterization

I. PURPOSE AND SCOPE

This SOP provides guidance to obtain accurate and consistent descriptions of soil characteristics during soil-sampling operations. The characterization is based on visual examination and manual tests, not on laboratory determinations.

II. EQUIPMENT AND MATERIALS

- Indelible pens
- Tape measure or ruler
- Field logbook
- Spatula
- HCL, 10 percent solution
- Squirt bottle with water
- Rock- or soil-color chart
- Grain-size chart
- Hand lens

III. PROCEDURES AND GUIDELINES

This section covers several aspects of the soil characterization: instructions for completing the CH2M HILL soil boring log Form 1586, field classification of soil, and standard penetration test procedures.

Instructions for Completing Soil Boring Logs

Soil boring logs will be completed in the field log books. Information collected will be consistent with that required for Form D1586, a standard CH2M HILL form.

The information collected in the field to perform the soil characterization is described below.

Field personnel should review completed logs for accuracy, clarity, and thoroughness of detail. Samples also should be checked to see that information is correctly recorded on both jar lids and labels and on the log sheets.

Heading Information

Boring/Well Number. Enter the boring/well number. A numbering system should be chosen that does not conflict with information recorded for previous exploratory work done at the site. Number the sheets consecutively for each boring.

Location. If stationing, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as "approximate" or "estimated" as appropriate.

Elevation. Elevation will be determined at the conclusion of field activities.

Drilling Contractor. Enter the name of the drilling company and the city and state where the company is based.

Drilling Method and Equipment. Identify the bit size and type, drilling fluid (if used), and method of drilling (e.g., rotary, hollow-stem auger). Information on the drilling equipment (e.g., CME 55, Mobile B61) also is noted.

Water Level and Date. Enter the depth below ground surface to the apparent water level in the borehole. The information should be recorded as a comment. If free water is not encountered during drilling or cannot be detected because of the drilling method, this information should be noted. Record date and time of day (for tides, river stage) of each water level measurement.

Date of Start and Finish. Enter the dates the boring was begun and completed. Time of day should be added if several borings are performed on the same day.

Logger. Enter the first initial and full last name.

Technical Data

Depth Below Surface. Use a depth scale that is appropriate for the sample spacing and for the complexity of subsurface conditions.

Sample Interval. Note the depth at the top and bottom of the sample interval.

Sample Type and Number. Enter the sample type and number. For instance, S-1 = split spoon, first sample. Number samples consecutively regardless of type. Enter a sample number even if no material was recovered in the sampler.

Sample Recovery. Enter the length to the nearest 0.1 foot of soil sample recovered from the sampler. Often, there will be some wash or caved material above the sample; do not include the wash material in the measurement.

Standard Penetration Test Results. In this column, enter the number of blows required for each 6 inches of sampler penetration and the "N" value, which is the sum of the blows in the middle two 6-inch penetration intervals. A typical standard penetration test involving successive blow counts of 2, 3, 4, and 5 is recorded as 2-3-4-5 and (7). The standard penetration test is terminated if the sampler encounters refusal. Refusal is a penetration of less than 6 inches with a blow count of 50. A partial penetration of 50 blows for 4 inches is recorded as 50/4 inches.

Sample may be collected using a 300-pound hammer or 3-inch-diameter split-spoon samples at the site. Use of either of these sample collection devices invalidates standard penetration test results and should be noted in the comments section of the log. The 300-pound hammer should only be used for collection of 3-inch-diameter split-spoon samples. Blow counts should be recorded for collection of samples using either a 3-inch split-spoon, or a 300-pound hammer. An "N" value need not be calculated.

Soil Description. The soil classification should follow the format described in the "Field Classification of Soil" subsection.

Comments. Include all pertinent observations (changes in drilling fluid color, rod drops, drilling chatter, rod bounce as in driving on a cobble, damaged Shelby tubes, and equipment malfunctions). In addition, note if casing was used, the sizes and depths installed, and if drilling fluid was added or changed. You should instruct the driller to alert you to any significant changes in drilling (changes in material, occurrence of boulders, and loss of drilling fluid). Such information should be attributed to the driller and recorded in this column.

Specific information might include the following:

- The date and the time drilling began and ended each day
- The depth and size of casing and the method of installation
- The date, time, and depth of water level measurements
- Depth of rod chatter
- Depth and percentage of drilling fluid loss
- Depth of hole caving or heaving
- Depth of change in material
- Drilling interval through a boulder

Field Classification of Soil

This section presents the format for the field classification of soil. In general, the approach and format for classifying soils should conform to ASTM D 2488-90, Visual-Manual Procedure for Description and Identification of Soils.

The Unified Soil Classification System is based on numerical values of certain soil properties that are measured by laboratory tests (ASTM D 2487). It is possible, however, to estimate these values in the field with reasonable accuracy using visual-manual procedures (ASTM D 2488-90, attached). In addition, some elements of a complete soil description, such as the presence of cobbles or boulders, changes in strata, and the relative proportions of soil types in a bedded deposit, can be obtained only in the field.

Soil descriptions should be precise and comprehensive without being verbose. The correct overall impression of the soil should not be distorted by excessive emphasis on insignificant details. In general, similarities rather than differences between consecutive samples should be stressed.

Soil descriptions must be recorded for every soil sample collected. The format and order for soil descriptions should be as follows:

1. Soil name (synonymous with ASTM D 2488-90 Group Name) with appropriate modifiers
2. Group symbol
3. Color
4. Moisture content
5. Relative density or consistency
6. Soil structure, mineralogy, or other descriptors

This order follows, in general, the format described in ASTM D 2488-90.

Soil Name

The basic name of a soil should be the ASTM D 2488-90 Group Name on the basis of visual estimates of gradation and plasticity. The soil name should be capitalized.

Examples of acceptable soil names are illustrated by the following descriptions:

- A soil sample is visually estimated to contain 15 percent gravel, 55 percent sand, and 30 percent fines (passing No. 200 sieve). The fines are estimated as either low or highly plastic silt. This visual classification is SILTY SAND WITH GRAVEL, with a Group Symbol of (SM).
- Another soil sample has the following visual estimate: 10 percent gravel, 30 percent sand, and 60 percent fines (passing the No. 200 sieve). The fines are estimated as low plastic silt. This visual classification is SANDY SILT. The gravel portion is not included in the soil name because the gravel portion was estimated as less than 15 percent. The Group Symbol is (ML).

The gradation of coarse-grained soil (more than 50 percent retained on No. 200 sieve) is included in the specific soil name in accordance with ASTM D 2488-90. There is no need to further document the gradation. However, the maximum size and angularity or roundedness of gravel and sand-sized particles should be recorded. For fine-grained soil (50 percent or more passing the No. 200 sieve), the name is modified by the appropriate plasticity/elasticity term in accordance with ASTM D 2488-90.

Interlayered soil should each be described starting with the predominant type. An introductory name, such as "Interlayered Sand and Silt," should be used. In addition, the relative proportion of each soil type should be indicated (see Table 1 for example).

Where helpful, the evaluation of plasticity/elasticity can be justified by describing results from any of the visual-manual procedures for identifying fine-grained soils, such as reaction to shaking, toughness of a soil thread, or dry strength as described in ASTM D 2488-90.

Group Symbol

The appropriate group symbol from ASTM D 2488-90 must be given after each soil name. The group symbol should be placed in parentheses to indicate that the classification has been estimated.

In accordance with ASTM D 2488-90, dual symbols (e.g., GP-GM or SW-SC) can be used to indicate that a soil is estimated to have about 10 percent fines. Borderline symbols (e.g., GM/SM or SW/SP) can be used to indicate that a soil sample has been identified as having properties that do not distinctly place the soil into a specific group. Generally, the group name assigned to a soil with a borderline symbol should be the group name for the first symbol. The use of a borderline symbol should not be used indiscriminately. Every effort should be made to first place the soil into a single group. Grain size is estimated in accordance with ASTM D 2488-90 (Table 2).

Table 2 GRAIN SIZE CLASSIFICATION (ASTM D-2488)	
Size (mm)	Name
>300	boulder
75-300	cobble
19-75	coarse gravel
4.75-19	fine gravel
2-4.75	coarse sand
0.425-2	medium sand
0.075-0.425	fine sand
<0.075	silt & clay

Color

The color of a soil must be given. The color description should be based on the Munsell system. The color name and the hue, value, and chroma should be given.

Moisture Content

The degree of moisture present in a soil sample should be defined as dry, moist, or wet. Moisture content can be estimated from the criteria listed on Table 3.

Table 3 CRITERIA FOR DESCRIBING MOISTURE CONDITION	
Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp, but no visible water; can be molded
Wet	Visible free water; usually soil is below water table

Relative Density or Consistency

Relative density of a coarse-grained (cohesionless) soil is based on N-values (ASTM D 1586-84, attached to SOP 4). If the presence of large gravel, disturbance of the sample, or non-standard sample collection makes determination of the *in situ* relative density or consistency difficult, then this item should be left out of the description and explained in the Comments column of the soil boring log.

Consistency of fine-grained (cohesive) soil is properly based on results of pocket penetrometer or torvane results. In the absence of this information, consistency can be estimated from N-values. Relationships for determining relative density or consistency of soil samples are given in Tables 4 and 5.

Table 4 RELATIVE DENSITY OF COARSE-GRAINED SOIL		
Blows/Ft	Relative Density	Field Test
0 - 4	Very loose	Easily penetrated with 1/2-in steel rod pushed by hand
5 - 10	Loose	Easily penetrated with 1/2-in steel rod pushed by hand
11 - 30	Medium	Easily penetrated with 1/2-in steel rod driven with 5-lb hammer
31 - 50	Dense	Penetrated a foot with 1/2-in steel rod driven with 5-lb hammer
>50	Very dense	Penetrated only a few inches with 1/2-in steel rod driven with 5-lb hammer

<p align="center">Table 5 CONSISTENCY OF FINE-GRAINED SOIL</p>		
Blows/Ft	Consistency	Field Test
<2	Very soft	Easily penetrated several inches by fist; sags under own weight
2 - 4	Soft	Easily penetrated several inches by thumb; easily pinched in two between thumb and forefinger
5 - 8	Firm	Can be penetrated several inches by thumb with moderate effort
9 - 15	Stiff	Readily indented by thumb, but penetrated only with great effort
16 - 30	Very stiff	Readily indented by thumbnail; barely imprinted by pressure from fingers
>30	Hard	Indented with difficulty by thumbnail; cannot be imprinted by fingers

Soil Structure, Mineralogy, and Other Descriptors

Discontinuities and inclusions are important and should be described. Such features include joints or fissures, slickensides, bedding or laminations, veins, root holes, and wood debris.

Significant mineralogical information such as cementation, abundant mica, or unusual mineralogy should be described.

Other descriptors may include particle size range or percentages, particle angularity or shape, maximum particle size, hardness of large particles, plasticity of fines, dry strength, dilatancy, toughness, reaction to HCl, and staining, as well as other information such as organic debris, odor, or presence of free product.

Equipment and Calibration

Before starting the testing, the equipment should be inspected for compliance with the requirements of ASTM D 1586-84. The split-barrel sampler should measure 2-inch or 3-inch O.D., and should have a split tube at least 18 inches long. The minimum size sampler rod allowed is "A" rod (1-5/8-inch O.D.). A stiffer rod, such as "N" rod (2-5/8-inch O.D.), is required for depths greater than 50 feet. The drive weight assembly should consist of a 140-pound or 300-pound hammer weight, a drive head, and a hammer guide that permits a free fall of 30 inches.

IV. ATTACHMENTS

ASTM D 2488-93: Standard Practice for Description and Identification of Soils (Visual-Manual Procedures).

V. KEY CHECKS AND PREVENTIVE MAINTENANCE

Check entries to the soil-boring log and field logbook in the field; because the samples will be disposed of at the end of fieldwork, confirmation and corrections cannot be made later. Check that sample numbers and intervals are properly specified. Check that drilling and sampling equipment is decontaminated using the procedures defined in SOP 9: Decontamination of Drilling Rigs and Equipment.

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Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)¹

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (See Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. For specific precautionary statements see Section 8.*

1.5 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 ASTM Standards:

D 653 Terminology Relating to Soil, Rock, and Contained Fluids²

D 1452 Practice for Soil Investigation and Sampling by Auger Borings²

D 1586 Method for Penetration Test and Split-Barrel Sampling of Soils²

D 1587 Practice for Thin-Walled Tube Sampling of Soils²
D 2113 Practice for Diamond Core Drilling for Site Investigation²

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)²

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)²

3. Terminology

3.1 Definitions:

3.1.1 Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:

Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and

Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1.2 *clay*—soil passing a No. 200 (75- μ m) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.1.3 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a 3/4-in. (19-mm) sieve.

fine—passes a 3/4-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.1.4 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.1.5 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.1.6 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and texture ranging from fibrous to amorphous.

3.1.1.7 *sand*—particles of rock that will pass a No. 4

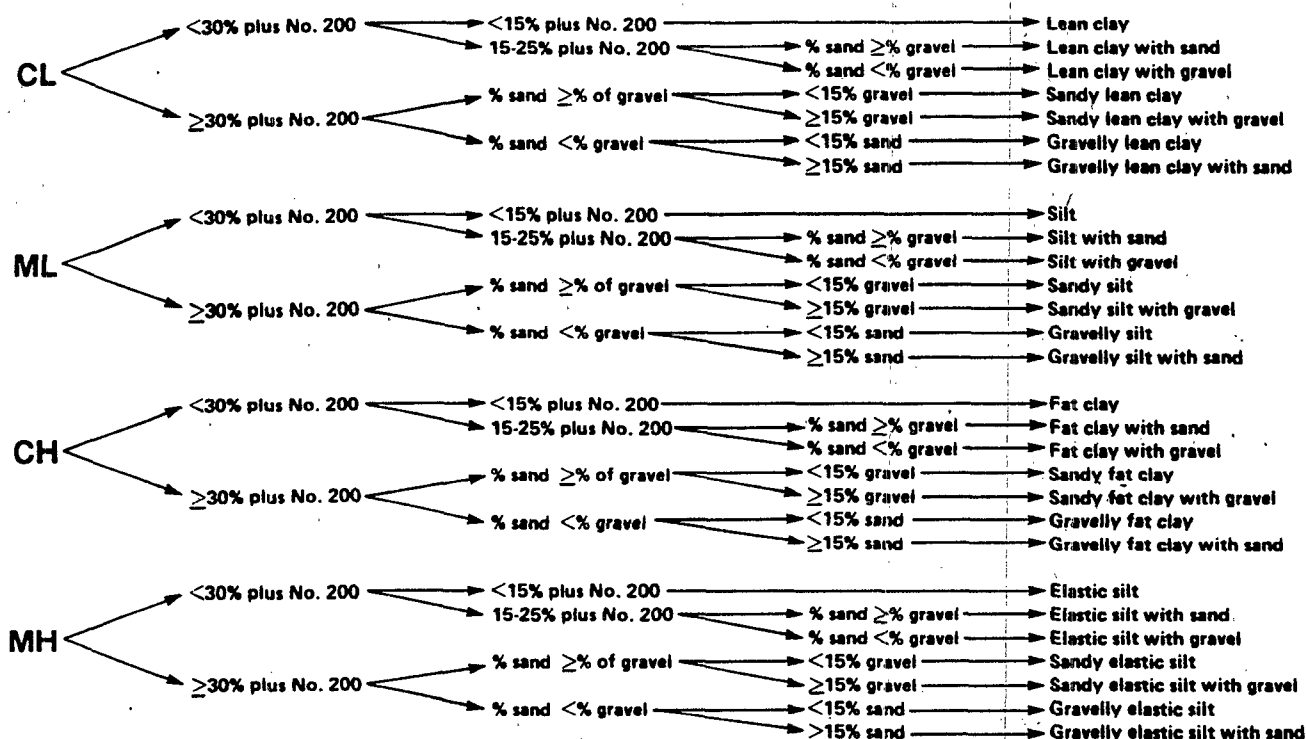
¹ This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

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² Annual Book of ASTM Standards, Vol 04.08.

GROUP SYMBOL

GROUP NAME



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)

(4.75-mm) sieve and be retained on a No. 200 (75-μm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-μm) sieve.

fine—passes a No. 40 (425-μm) sieve and is retained on a No. 200 (75-μm) sieve.

3.1.1.8 *silt*—soil passing a No. 200 (75-μm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the “A” line (see Fig. 3 of Test Method D 2487).

4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

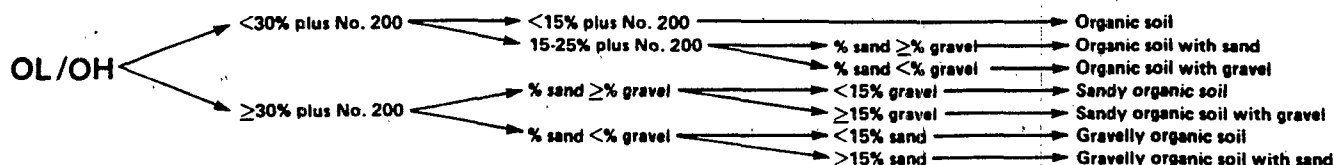
4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Figs. 1a and 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols*.

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or

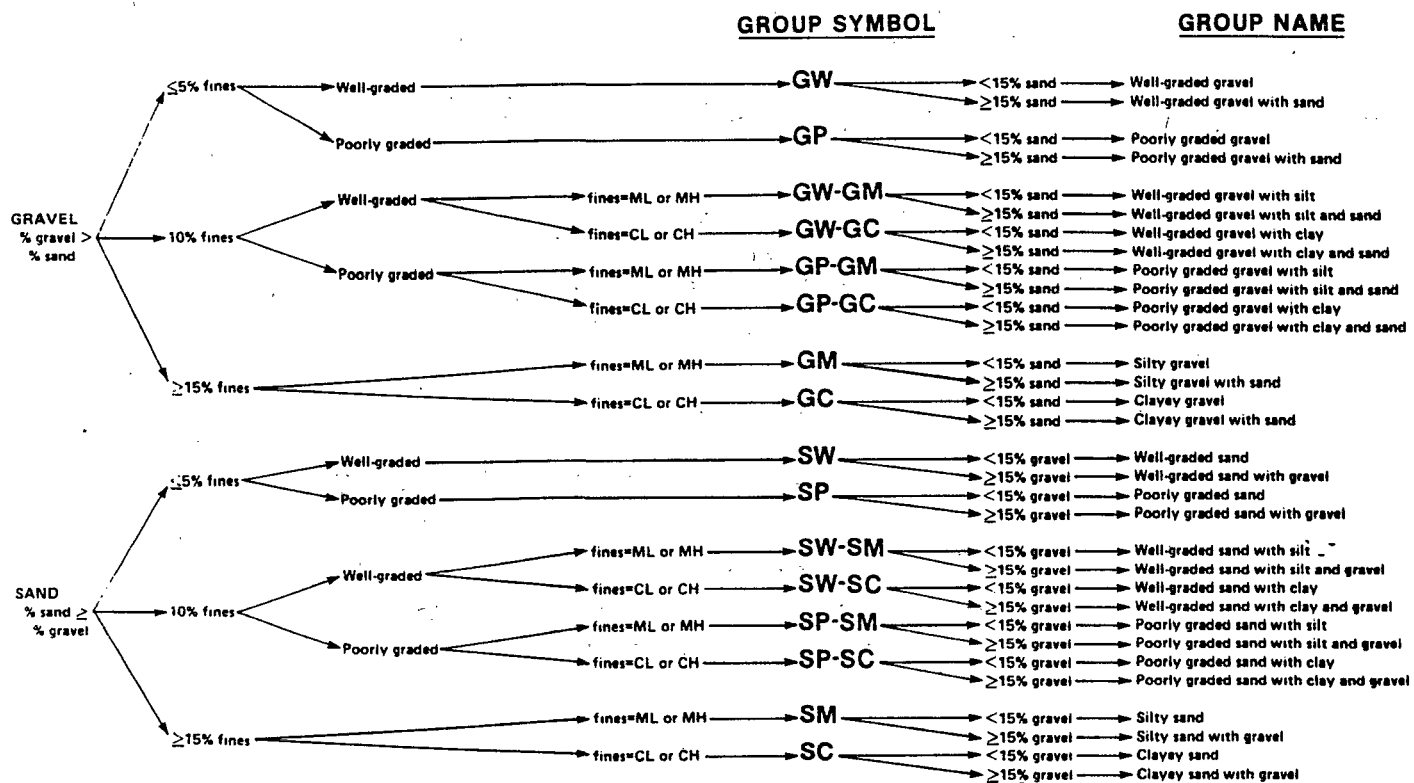
GROUP SYMBOL

GROUP NAME



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test

results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

6. Apparatus

6.1 Required Apparatus:

6.1.1 Pocket Knife or Small Spatula.

6.2 Useful Auxiliary Apparatus:

6.2.1 Small Test Tube and Stopper (or jar with a lid).

6.2.2 Small Hand Lens.

7. Reagents

7.1 **Purity of Water**—Unless otherwise indicated, references to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 **Hydrochloric Acid**—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 N) to three parts water (This reagent is optional for use with this practice). See Section 8.

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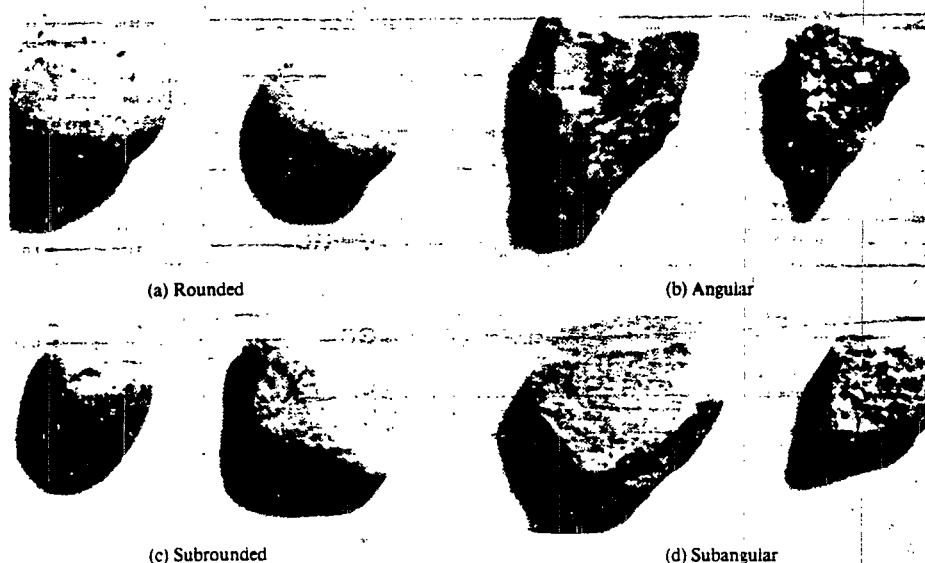


FIG. 3 Typical Angularity of Bulky Grains

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 5—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 6—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (3/8 in.)	200 g (0.5 lb)
19.0 mm (3/4 in.)	1.0 kg (2.2 lb)
38.1 mm (1 1/2 in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 7—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 **Angularity**—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 **Shape**—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 **Color**—Describe the color. Color is an important property in identifying organic soils, and within a given

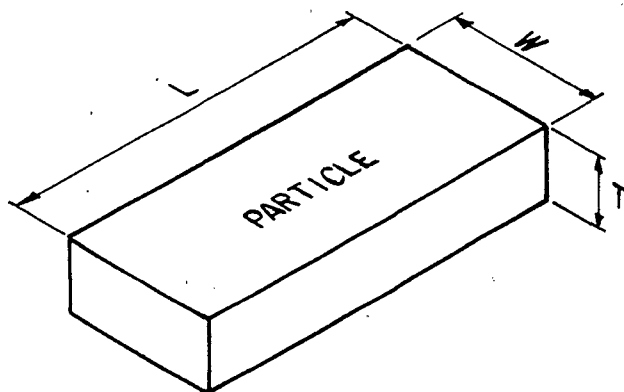
TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

PARTICLE SHAPE

W = WIDTH
T = THICKNESS
L = LENGTH



FLAT: $W/T > 3$
ELONGATED: $L/W > 3$
FLAT AND ELONGATED:
—meets both criteria

FIG. 4 Criteria for Particle Shape

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the criteria in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about 1/4 in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1 1/2 in. (will pass a 1 1/2-in. square opening but not a 3/4-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation.

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

tation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 8—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 9—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more

fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 Dry Strength:

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about 1/2 in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about 1/2 in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 10—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accordance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 Dilatancy:

14.3.1 From the specimen, select enough material to mold into a ball about 1/2 in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

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TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 Toughness:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about 1/8 in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about 1/8 in. The thread will crumble at a diameter of 1/8 in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 Plasticity—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 Identification of Inorganic Fine-Grained Soils:

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A 1/8-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 11—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 Identification of Organic Fine-Grained Soils:

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 12—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils (Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 13—Example: *Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
 - Gravel—fine, coarse
 - Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong
- For intact samples:
18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 14—Other examples of soil descriptions and identification are given in Appendixes X1 and X2.

NOTE 15—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %

Few—5 to 10 %

Little—15 to 25 %

Some—30 to 45 %

Mostly—50 to 100 %

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

XI. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray;

in-place density 106 lb/ft³; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incorporated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to

100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; "Poorly Graded Gravel with Sand (GP)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two

possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the

percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-

grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size

present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix:	Suffix:
s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

X6. RATIONALE

Changes in this version from the previous version, Classification Symbols.
D 2488 - 90, include the addition of X5 on Abbreviated Soil

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SOP 5: Sediment Sampling

I. PURPOSE AND SCOPE

This procedure provides guidance for sediment sampling.

II. EQUIPMENT AND MATERIALS

- Stainless steel tray
- Hand tools (spoon, scoop, trowel, etc.)
- Shelby tubes
- Sample bottles
- Logbook
- Dredge (Ponar or Eckman type)
- Corers

III. PROCEDURES AND GUIDELINES

Sediments are typically collected as composite samples; that is, several (typically three or more) smaller sediment samples are taken across the width of a stream and mixed, or samples are taken at several points (typically three to five) and homogenized. Sediments may be layered as a result of differential settling rates or different sized fractions. To obtain layered samples, undisturbed cores may be sought, the individual layers may be skimmed off to constitute a sample, or a homogenized sample may be sieved or filtered to separate out the desired fraction.

Streams, lakes, and impoundments may show significant variations in sediment composition related to distance from inflows, discharges, or other disturbances. In addition, the presence of rocks, debris, and organic material may complicate sampling and preclude the use of or require modification of some devices. Large areas may be divided into grids, and multiple samples can be collected and composited. Sampling locations are documented in the field logbook.

All sampling devices are cleaned and decontaminated in accordance with SOP 1. Specific instructions for typical sampling methods are provided below.

A. Spoon, Scoop, and Other Sample Devices

When sediments are exposed by evaporation, stream rerouting, or other means of water loss, they may be collected by scoops, spoons, or trowels. When the liquid layer is sufficiently shallow, sludges or sediments may also be collected using a scoop or a thin-tube sampler. The thin-tube sampler is preferable, because it creates less sample disturbance and also collects some

overlying liquid, thus preventing drying or excessive sample oxidation before analysis.

The following steps are taken for sediment sampling with simple devices:

1. The sample area, including any recognizable features, is sketched in the field logbook for future reference.
2. The sampling device is inserted into material to remove the sample. If the material has been exposed to air, it may be desirable to remove and discard an upper layer before collecting the sample.
3. If compositing a series of grab samples, a stainless steel mixing bowl or Teflon tray is used for mixing.
4. The sample is transferred into an appropriate sample container with a stainless steel spoon, scoop, and spatula. Either a new tool must be used to transfer each sample or the tool must be cleaned and decontaminated between contacts, as described in SOP 1.
5. The cap is tightly secured. Chemical preservation of solids is generally not used, but samples should be refrigerated to 4°C.

B. Ponar and Eckman Dredges

The Ponar dredge is a clamshell scoop activated by a scissors-like closing system. The shell is opened, latched in place, and slowly lowered to the bottom. When tension is released on the lowering cable, the latch releases and the lifting action of the cable on the lever system closes the clamshell. The Eckman dredge is a spring-loaded, clamshell-type scoop activated when it lands on the sediments, releasing the springs. Eckman dredges are used in sediments too soft for the Ponar.

The sampling action of these devices causes agitation that may temporarily resuspend some settled solids. This disturbance is minimized by slowly lowering the dredge the last few feet to allow gentle contact with the bottom.

Dredge sampling is performed as follows:

1. The sampling point is located using triangulation with onshore points if necessary. The location, with any recognizable features, is noted in the field logbook.
2. The dredge is attached to the necessary length of sample line. Solid braided 3/16-inch nylon line is usually of sufficient strength, but a larger diameter nylon line facilitates hand hoisting.

3. The distance to bottom is measured and marked on the sample line. A secondary proximity mark, 3 feet shallower, is used to indicate when the lowering rate should be reduced to prevent unnecessary bottom disturbance.
4. The sampler jaws are opened until latched. From this point on, the Ponar must be supported by its lift line or the sampler will be tripped and the jaws will close. With the Eckman dredge, care should be taken to avoid triggering springs.
5. The free end of the sample line is tied to a fixed support to prevent loss of sampler.
6. The Ponar dredge is lowered until the 3-foot proximity mark is reached, and the rate of descent is slowed until contact is felt. The Eckman is allowed to free fall until contact is made.
7. The sample line is allowed to slacken until the mechanism is released.
8. The dredge is slowly raised and placed in a stainless steel or Teflon tray for opening.
9. The sample is transferred into an appropriate sample bottle with a stainless steel spoon, scoop, or spatula. Either a new tool must be used to transfer each sample or the tool must be cleaned and decontaminated between contacts, as described in SOP 1.

C. Hand and Gravity Corers

Corers consist of a stainless steel barrel with optional liners, a nosepiece, and an "eggshell" core catcher. Hand corers have a handle to facilitate driving the corer and a check valve on top to prevent washout during retrieval. Gravity corers have a check valve to allow water to flow through the unit during descent; the check valve closes upon retrieval to prevent washout.

1. Hand Corers

The following method is used to sample with a hand corer:

- a. The sample location is selected and recorded in the field logbook.
- b. The corer is forced into the media, twisted, and withdrawn in a single smooth motion.

- c. The nosepiece is removed and the sample allowed to slide into a stainless steel or Teflon tray.
- d. The sample is transferred into an appropriate sample bottle with a stainless steel spoon or equivalent. Either a new tool must be used to transfer each sample or the tool must be cleaned and decontaminated between contacts, as described in SOP 1.

2. Gravity Corers

To sample with a gravity corer, the following steps are taken:

- a. The sampling point is located by triangulation to points on shore and noted in the field logbook.
- b. The corer is attached to the required length of sample line. Solid braided 3/16-inch nylon line is normally sufficient, but a larger diameter line is easier to grasp during hand hoisting. An additional weight can be attached to the outside of the corer, if necessary. The distance to the bottom is measured and marked on the sample line.
- c. The free end of the line is tied to a fixed support to prevent loss of the corer.
- d. The corer is allowed to free fall through the liquid to the bottom.
- e. The corer is retrieved with a smooth, continuous motion.
- f. The nosepiece is removed and the sample allowed to slide into a stainless steel or Teflon tray.
- g. The sample is transferred into an appropriate sample bottle with a stainless steel scoop, spoon, or spatula. Either a new tool must be used to transfer each sample or the tool must be cleaned and decontaminated between contacts, as described in SOP 1.

IV. REFERENCES

None.

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SOP 6: Surface Water Sampling

I. PURPOSE AND SCOPE

This procedure presents the techniques used in collecting surface water samples.

II. MATERIALS AND EQUIPMENT

Materials and equipment vary depending on type of sampling. More detail is found in Section III text.

- Open tube sampler
- Dip sampler
- Weighted bottle sampler
- Hand pump
- Kemmerer or Van Dorn sampler
- Depth-integrating sampler
- Sample containers
- Meters for specific conductance, temperature, pH, and dissolved oxygen

III. PROCEDURES AND GUIDELINES

Before surface water samples are taken, all sampler assemblies and sample containers are cleaned and decontaminated as described in SOP 1. All sample bottles are labeled and handled in accordance with the FSP. Method for taking surface water samples are described below.

A. Manual Sampling

Surface water samples are taken manually by submerging a clean glass, stainless steel, or Teflon container into the water body. Samples may be taken at depth with a covered bottle that can be removed with a tripline. The most common sampler types are beakers, sealable bottles and jars, pond samplers, and weighted bottle samplers. Pond samplers have a fixed or telescoping pole attached to the sample container. Weighted bottle samplers are lowered below water surface, where the attached bottle is opened, allowed to fill, and pulled out of the water. When retrieved, the bottle is tightly capped and removed from the sampler assembly. Specific types of weighted bottle samplers include dissolved oxygen, Kemmerer, or Van Dorn, and are acceptable in most instances.

A sample is taken with the following specific steps:

1. The location and desired depth for water sampling are selected.

2. The sample site is approached from downstream in a manner that avoids disturbance of bottom sediments as much as possible. The sample bottle is gently submerged to just below the water surface with the mouth pointed upstream and the bottle tilted slightly downstream. Bubbles and floating materials should be prevented from entering the bottle.
3. For weighted bottle samplers, the assembly is slowly lowered to the desired depth. The bottle stopper is unseated with a sharp tug and the bottle is allowed to fill until bubbles stop rising to the surface.
4. When the bottle is full, it is gently removed from the water. If sample transfer is required, it should be performed at this time.

B. Mechanical Sampling

Mechanical surface water sampling involves a peristaltic pump that conveys water through heavy-walled tubing to a container. The tubing must be flexible and made of a non-reactive material such as Tygon or Teflon; Teflon is usually selected when oil and grease are present. Medical-grade or silicon tubing may be satisfactory in some cases, depending on the constituents to be analyzed. An external power source may be required, but many peristaltic pumps are equipped with batteries.

In some situations, it may be desirable or necessary to locate the container between the water intake and the pump connection. The peristaltic pump may then be used as a vacuum pump. The vacuum pump method cannot be used for samples on which analyses for volatile organic compounds (VOCs) will be conducted, as it very effectively strips VOCs from water.

When sampling at depths or in fast currents, the inlet tubing is weighted or attached to some stationary object such as a bridge piling or a pole stuck in bottom sediments. Weighting the tubing can cause stretching and reduce the inside tubing diameter, which reduces pump capacity. Insertion of a pole into bottom sediments adds particulates to the water column. Water sampling should not commence until particulates have settled.

The following steps are taken in mechanical surface water sampling:

1. The inlet and outlet tubing is connected to the appropriate ports located on the pump housing. The interior of the housing is checked to be sure that the pump tubing is properly connected.
2. The intake end of the inlet tubing is placed at the selected sample location, and the discharge end of the outlet tubing is placed in the sample container. The sample is pumped until the sample container

is full. The pump may be allowed to run for a period of time to flush the sampling device before collecting a sample.

3. When the pump is stopped, the discharge end of the outlet tube is removed from the sample container. The sample container is capped and labeled.
4. If the peristaltic pump is being used as a vacuum pump, the inlet tubing at the top of the collection container is detached first. This prevents back-siphoning when the vacuum is released. The vacuum is released by slowly admitting air as the inlet tubing is disconnected to prevent blow-back and reduce aeration of the sample. After the vacuum is released, the sample is transferred to a sample bottle.
5. Peristaltic pumps are cleaned and decontaminated by disposing of the interior and exterior tubing. Tubing is difficult to completely clean, particularly of oils and greases.

IV. REFERENCES

None.

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SOP 10: Field Filtering

I. PURPOSE

To provide a general guidelines for the field filtering of water samples for dissolved metals analysis.

II. SCOPE

Standard method of field filtering techniques.

III. EQUIPMENT AND MATERIALS

- Geotech filtering apparatus
- Pump
- 25% nitric acid (HNO_3) solution — high grade — reagent grade not acceptable
- Glass fiber prefilters
- Vacuum source
- 0.45 μm cellulose acetate filters
- Q.E.D. online filters

IV. PROCEDURES AND GUIDELINES

A. REAGENT PREPARATION

1. 10% HNO_3 solution: Add about 900 ml of DI water to a 1 liter Erlenmeyer flask. Using a graduated cylinder, add 100 ml concentrated HNO_3 to the DI water while stirring.

B. PROCEDURE

1. Attach a vacuum source (pump, syringe, etc.) or a Q.E.D. online filter to the receiver assembly.
2. Flush the entire filter system with 25% HNO_3 solution. Open assembly, discard rinsate, and reassemble unit.
3. Flush the entire filter system with 60 ml HPLC water. Open assembly, discard rinsate and reassemble unit (not required when using Q.E.D. online filter).
4. Filter sample and transfer to polyethylene bottle (with preservative) for shipment.

5. Discard filter assembly and prefilter.

V. ATTACHMENTS

None.

VI. KEY CHECKS AND ITEMS

- 25% HNO₃ solution for cleaning
- All water must be deionized
- Prefilter with glass fiber filters if sample is turbid
- Record lot number of nitric acid and deionized water
- Note monitoring wells with high concentrations of suspended solids in field notebooks

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SOP 11: Field Measurement of Organic Vapors Using an HNU or OVM

I. PURPOSE

To provide general guidelines for the calibration and use of the HNU or OVM photoionization detector.

II. SCOPE

This is a broad guideline for the field use of an HNU or OVM. For specific instructions, refer to the operations manual.

III. HNU EQUIPMENT AND MATERIALS

- Operations manual
- An HNU readout/control unit and photoionization probe (either 10.2 or 11.7 eV depending on requirements) with fully charged battery pack
- Charging unit
- A cylinder of calibration gas, typically 100 ppm isobutylene in air
- A regulator for the calibration gas cylinder
- A short length of 1/8th-inch tube to transfer calibration gas from the cylinder to the HNU probe (as short as possible)

IV. HNU PROCEDURES AND GUIDELINES

ONLY PROPERLY TRAINED PERSONNEL SHOULD USE THIS INSTRUMENT. FOR SPECIFIC INSTRUCTIONS, SEE OPERATIONS MANUAL.

A. CALIBRATE THE HNU

1. Identify the probe by lamp model.
2. Connect the sensor/probe to the readout/control unit.
3. Perform a battery check by turning the function switch to "Batt."

4. Turn function switch to "Standby" and set the readout to zero by turning the zero knob.
5. Hold the sensor/probe to your ear to verify that it is powered. A faint humming sound will be heard.
6. Set the range to the appropriate setting.
7. Connect the tube from the calibration gas cylinder to the end of the probe and open the valve on the calibration gas cylinder.
8. Sample the calibration gas and adjust to the proper reading with the span control knob.
9. If calibration cannot be achieved, disassemble the sensor/probe assembly and clean lamp. If the span knob setting is at the end of the span range, unit must be serviced by qualified personnel.

B. SAMPLING WITH THE HNU

1. Once calibration is complete, unit is ready for sampling. When not in use, set function knob to "Standby."
2. When done for the day, turn unit off and disconnect the sensor/probe.
3. Charge the battery overnight (complete recharge takes 14 hours).
4. For preventive maintenance, refer to instruction manual.

V. OVM EQUIPMENT AND MATERIALS

- Operations manual
- An OVM data logger (either 10.0, 10.6, or 11.8 eV lamp depending on requirements) with fully charged battery pack and air filter (silver in-line filter, or plastic disk in-line filter)
- Charging unit
- A cylinder of calibration gas, typically 100 ppm isobutylene in air
- A 1.5 L/min regulator for the calibration gas cylinder
- T-tube of 1/8th-inch transfer tubing to transfer the calibration gas from the cylinder to the OVM

VI. PROCEDURES AND GUIDELINES

ONLY PROPERLY TRAINED PERSONNEL SHOULD USE THIS INSTRUMENT. FOR SPECIFIC INSTRUCTIONS SEE OPERATION MANUAL.

A. OPERATION

1. Power-up instrument by plugging in the power plug or the charger cable.
2. Depress "ON/OFF" key to ignite lamp and initiate sample pump. "LAMP OUT" will be displayed until lamp is ignited. Unit is now operational.

B. SETTING ZERO

1. Depress "MODE/STORE" key.
2. Using "-/CRSR" key, scroll through: "LOG THIS VALUE"—"R/COMM"—"CONC METER"—"FREE SPACE"—"RESET TO CALIBRATE." Display should read "RF=___."
3. Depress "RESET" and "-/CRSR" keys simultaneously to select cursor position.
4. Depress "RESET" and "+/INC" keys simultaneously to scroll through preset response factor (RF) values. Set RF = 1.00.
5. Using "-/CRSR" key, scroll through "LAMP"—"ALM"—"AVERAGE"—"LOC. CODE MODE"—"AUTO LOGGING"—"CONC. METER"—"FREE SPACE." Display should read "RESET TO CALIBRATE." Depress "RESET" key.
6. Depress "-/CRSR" in response to "RESTORE BACKUP" prompt.
7. Depress "RESET" key. Instrument will zero to ambient air. (Note: Zero gas or a zero filter may be used to set the unit to an absolute zero—connect prior to depressing a "RESET" key.)

C. CALIBRATION

1. Instrument should display "SPAN PPM = --- + TO CONTINUE."
2. Depress "RESET" and "-/CRSR" keys simultaneously to select cursor position.

3. Depress "RESET" and "+/INC" keys simultaneously to scroll through preset SPAN values. Set SPAN = 100, which corresponds to the 100 ppm isobutylene.
4. When span has been entered, depress "+/INC" key to continue.
5. Connect span gas cylinder. Turn valve on. Depress "RESET" key.
6. When finished calibrating, display will read "RESET TO CALIBRATE." Depress "MODE/STORE" key. Display should read about 100 ppm. Turn valve off. Disconnect span gas cylinder. Unit is now operational.

D. SETTING RF TO MIMIC HNU

1. Depress "MODE/STORE" key.
2. Using "-/CRSR" key, scroll through: "LOG THIS VALUE"—"R/COMM"—"CONC METER"—"FREE SPACE"—"RESET TO CALIBRATE." Display should read "RF = 1.00."
3. Depress "RESET" and "-/CRSR" keys simultaneously to select cursor position.
4. Depress "RESET" and "+/INC" keys simultaneously to scroll through preset RF values. Set RF = 0.55 (10.0 eV or 10.2 eV lamp) or RF = 0.68 (11.8 eV lamp). Depress "MODE/STORE" key. Unit is now operational.

E. SETTING THE ALARM

1. Depress "MODE/STORE" key. Use "-/CRSR" key to scroll to "ALM". Depress "RESET" and "-/CRSR" keys simultaneously to select cursor position.
2. Depress "RESET" and "+/INC" keys simultaneously to scroll through preset alarm values. Set alarm to desired level.
3. Depress "MODE/STORE" key. Unit is now operational.

F. ERASING PREVIOUS DATAPOINTS

1. Depress "MODE/STORE" key. Use "-/CRSR" key to scroll to "R/COMM." Depress "RESET" key.

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- If "NO DATA STORED" is displayed, depress "MODE/STORE" key. Unit will display "COMPUTER." Depress "MODE/STORE" key. Unit is operational.
 - If "COMMUNICATE" is displayed, depress "-/CRSR" key in response to "COMMUNICATE" and "DISP. LOG DATA" prompts.
2. Depress "+/INC" key in response to "RESET" prompt. Depress "MODE/STORE" key. Unit is operational. All datapoints have been erased.

G. STORING A DATAPOINT

1. Depress "MODE/STORE" key when you want to store a datapoint. Depress "+/INC" key to store the point. Use the "+/INC" key to set datapoint number or location code; use "-/CRSR" key to move cursor.
2. Depress "MODE/STORE" key. Unit is operational.

H. RETRIEVING A DATAPOINT

1. Depress "MODE/STORE" key. Use "-/CRSR" key to scroll to "R/COMM." Depress "RESET KEY". Depress "-/CRSR" key in response to "COMMUNICATE" prompt. Depress "+/INC" key in response to "DISP. LOG DATA" prompt. Datapoint(s) and the date/time of collection will be displayed.
2. Continue to depress "+/INC" key to display additional datapoints and return to the operational mode.

I. TURNING THE AUTOLOGGER FUNCTION ON

1. Depress "MODE/STORE" key. Use "-/CRSR" key to scroll to "AUTO LOGGING" prompt. Depress "RESET" key. Depress "+/INC" key.
2. Select autologging interval MM:SS. Use "-/CRSR" key to move cursor. Use "+/INC" key to select preset values.
3. Depress "RESET" key. Depress "MODE/STORE" key. Unit is now operational.

J. TURNING THE AUTOLOGGER FUNCTION OFF

1. Depress "MODE/STORE" key. Use "-/CRSR" key to scroll to "AUTO LOGGING" prompt. Depress "RESET" key. Depress "-/CRSR" key.
2. Depress "MODE/STORE" key. Unit is now operational.

VII. ATTACHMENTS

Instrument profile OVM data logger
HNU calibration sheet
OVM calibration sheet

VIII. KEY CHECKS AND ITEMS

- Check battery.
- Zero and calibrate.
- Verify sensor probe is working.
- Recharge unit after use.

IX. PREVENTIVE MAINTENANCE

A complete preventive maintenance program is beyond the scope of this document. For specific instructions, refer to the operations manual.

- A complete spare HNU or OVM should be available on site whenever field operations require this instrument.
- A spare lamp should be on hand so a defective unit can be changed without returning the unit.
- Occasional cleaning of the lamp should be performed as needed.
- Charge batteries daily.
- Occasionally allow the batteries to totally discharge before recharging to prevent battery memory from occurring.

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Instrument Profile: Organic Vapor Meter Data (OVM) Logger

- Hazard Monitored:** Organic and inorganic vapors and gases.
- Application:** Determines relative concentrations of air contaminants. Information used to establish level of protection and other control measures. It will not detect methane.
- Components:** Single, integrated unit; interchangeable ultraviolet lamp sources (10.0, 10.6, and 11.8 eV); LCD digital readout, with bargraph; keypad controls instrument functions; positive displacement sampling pump; datalogger function can store 700 data points by date, time, location, and status.
- Detection Method:** Photoionization.
- Operation:** Ultraviolet light photons are generated by the UV lamp and directed at the sample. If the energy of the photons is sufficient it will ionize the molecules of vapor/gas in the sample. The amount of energy necessary to photoionize a molecule is represented by its ionization potential (IP). The lamp energy must be equal to or greater than the IP of a compound. Once ionized, the freed electrons are collected at an electrode to generate a current, which corresponds to concentration, and is displayed on the readout.
- Readout:** Continuous LCD digital readout with bargraph, overrange indication, and audible alarm; linearized range 0.1 to 2000 ppm; auto ranging 0-200 ppm and 200-2000 ppm; maximum concentration signal hold; communications software available.
- Calibration:** This instrument is calibrated with isobutylene gas. The calibration should be checked before and after use. Refer to Table 1. Note that the unit is initially calibrated to respond "one-to-one" to isobutylene (RF=1.0). The RF should then be set to 0.55 (10.0 and 10.6 eV lamps) or 0.68 (11.8 eV lamp), which causes the OVM to mimic the HNU PID. The EPA total vapor action levels are based on HNU readings (HSP).
- Inherent Safety:** The OVM is approved for Class I Division 2 Groups ABCD.

SOP 7: Groundwater Sampling

I. PURPOSE

General reference information for sampling groundwater monitoring wells is provided.

II. SCOPE

Standard groundwater sampling techniques and low flow purging techniques using the appropriate sampling equipment are summarized. Site-specific details are discussed in related sections of the FSP.

III. EQUIPMENT AND MATERIALS

- Water level indicator
- Decontamination solution for cleaning water level indicator
- Zip strips
- Adjustable rate purge and sampling pumps compatible with the well diameter
- Calibrated bucket to measure volume of water purged
- Plastic sheeting to lay on ground around the well
- In line flow-through cell equipped with ports for pH, Eh, DO, specific conductivity and temperature electrodes
- Bottles and preservatives (if required)
- Personal protection - latex or surgical gloves, etc. (REFER TO SITE SAFETY PLAN)
- pH/Eh meter, specific conductivity meter, thermometer, dissolved oxygen meter

IV. PROCEDURES AND GUIDELINES

General

Prior to sampling, each well will be monitored using an HNU or OVM organic vapor analyzer (see SOP 11).

NOTE: Execute a sampling route that will begin with the wells with the least contamination proceeding to the wells with the most contamination to reduce the chance of cross contamination affecting sample results.

1. Check the condition of the well and look for damage or evidence of tampering and record. Set up a table in the log book for sampling parameters, discharge, and water levels. Check summary sheet showing well construction, previous sampling information, and purging data.
2. Remove the well cap and measure the well headspace with a PID. Record the measurement.
3. With a water level indicator, measure the depth to water surface. Check well construction data for total depth of well. Do not measure total depth at this time unless data is unavailable. Decontaminate water level indicator when done.
4. Calculate the volume of water in the well with the following equation:

$$V = 3.14 \times (D^2/4) \times H \times 7.48 \text{ g/ft}^3$$

Where: V = total volume of water to be purged (gallons)
D = inside diameter of the well (ft)
H = height of water column in the well (ft)
(depth to bottom of well minus depth to water)

5. Lay out plastic sheeting in areas where equipment must be set on the ground.

Low Flow Purging Techniques

1. Install pump in the well. The pump intake should be set adjacent to a productive zone in the well. The pump intake should be at least 2 feet off the bottom of the well, to avoid mobilization of any sediment present. The wires and tubes attached to the pump should be bundled together with zip strips in such a fashion that they will not hinder water level measurements. If the well is expected to be highly productive, commence purging at 1 to 2 gpm. For less productive wells, start purging at 0.25 to 0.5 gpm. Avoid surging.

2. The water level in the well should be monitored during purging. The water level should stabilize for the specific pump rate, at least 1-foot over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. The goal is to have the purge rate exactly equal the recharge rate. Also, try to avoid allowing the water level to drop below the top of the screen zone, or in rock wells below a productive fracture zone. Record discharge rate and water levels periodically.
3. The well should not be purged dry. If the recharge rate of the well is so low that the well is purged dry, then the well should be sampled as soon as a sufficient volume of water has recharge the well casing.
4. During well purging, use the flow-through cell to monitor the field parameters (SOPs 14-16) frequently (every 5 to 10 minutes) until the parameters have stabilized to within 10 percent (plus or minus 5 percent) over a minimum of three readings. If the water appears turbid, then the stabilization range can be amended to 20 percent (plus or minus 10 percent) over a minimum of three readings.

The flow-through cell should be constructed such that water flows past the probes gently. The walls of the cell should not touch any portion of the probes that will adversely affect their measuring capacity. The D.O. Probe membrane should be adjacent to the cell intake, with membrane perpendicular to the flow.

5. Once the field parameters have stabilized, collect the samples from a sampling tap upstream of the flow-through cell. Sample VOCs first (SOP 8) followed by semivolatiles and then TOC. All sample bottles should be filled by allowing the water to flow gently down the inside of the bottle with minimum turbulence. Cap each bottle as it is filled.
6. If parameters do not stabilize within 2 hours, switch to standard sampling techniques.

Standard Sampling Techniques

1. Purge three to five well volumes to remove stagnant water. A pump or bailer can be used. Purge water as near to the water surface as possible to assure that no stagnant water remains in the well above the well screen. Purge water should be placed in a calibrated bucket so total volume removed can be measured. While purging, temperature, specific conductance, D.O., turbidity, and pH should be measured at least once per well volume. These measurements will provide evidence of stability. Measure field parameters following SOP 1 and SOP 2.

Stabilization of field parameters is obtained when variability of field parameters is as follows:

- pH \pm 0.5 units
- Temp \pm 1°C
- Specific Conductance \pm 10%

Eh will also be measured but its stabilization will not be a criteria for ending purging.

If stability is indicated at three well volumes, sampling can begin. If not, continue to purge until stable conditions are achieved or five well volumes have been removed. If well is purged dry, wait 15 minutes, allowing well to recover. Collect sample as soon as there is sufficient water required for intended analysis.

2. **SAMPLING BY BAILER** (sampling by pump, below, is preferred): Clean latex or surgical gloves must be worn at all times. Place a large, clean plastic sheet on the ground around the well. Attach sufficient clean teflon-coated line (10 feet or more) to the bailer to reach to the desired depth, and secure the end to something (well cap, sampler's wrist, etc.) that will prevent the line from being lost down the well. Slowly lower the bailer into the well. Do not let the bailer "free fall" and do not allow the bailer to touch the bottom. Try to lower the bailer to the same approximate depth each time, preferably within or just above the screened area. Retrieve the bailer smoothly and do not let the line rub against the side of the casing or touch the ground. Slowly pour the sample into the appropriate container from the bottom check valve. For sampling order, see special note below. When done, remove and discard line and thoroughly decontaminate bailer before reusing.
3. **SAMPLING BY PUMP**: Position the pump inlet in the well so the water removed is from the same portion of the well, preferably within the screened area. Set the discharge of the pump to a slow rate. Direct the sample into the container in the same manner as with the bailer. The tubing that comes in contact with the water should be Teflon. The preferred method to sample VOCs is with a Q.E.D. well-wizard bladder pump. The pump and all associated equipment that contacts the water or inside portion of the well must be thoroughly decontaminated before reusing.
4. When filling bottles, sample VOCs, semivolatiles, and TOC (in that order) before sampling for other analytes. For sampling VOCs, see SOP No. 8, "VOC Sampling--Water."

V. ATTACHMENTS

None.

VI. KEY CHECKS AND ITEMS

- Cover ground.
- Wear latex or surgical gloves as appropriate, (see HSP).
- Secure bailer line end.
- For VOC sampling: Use Q.E.D. well wizard bladder pump only (if appropriate); check for bubbles.

WDCR826/021.WP5

SOP 8: VOC Sampling—Water

I. PURPOSE

To provide general guidelines for sampling aqueous volatile organic compounds.

II. SCOPE

Standard techniques for collecting representative samples are summarized. Site specific details are discussed in the FSP.

III. EQUIPMENT AND MATERIALS

- Sample vials
- Hydrochloric acid (HCl) for preservation
- pH meter or pH indicating paper
- Surgical or latex gloves

IV. PROCEDURES AND GUIDELINES

1. Sample VOCs before sampling other analyte groups.
2. When sampling for VOCs, evaluate the area around the sampling point for possible sources of air contamination by VOCs. Products that may give off VOCs and possibly contaminate a sample include perfumes and cosmetics, skin applied pharmaceuticals, automotive products (gasoline, starting fluid, windshield deicers, carburetor cleaners, etc.) and household paint products (paint strippers, thinners, turpentine, etc.).
3. To check the amount of hydrochloric acid (HCl) that needs to be added at each location, fill a test vial (40 ml) with the water to be sampled, add one drop of hydrochloric acid (HCl), gently mix, and check the pH. Repeat this cycle (if necessary) until you reach a pH of 2, counting the number of drops of HCl required. **DISCARD THE TEST VIAL** and add an equal number of drops of HCl to each of the sample vials. Proceed to sample.
4. Keep the caps off the sample vials for as short a time as possible.
5. Wear clean gloves.

6. Fill the sample vial immediately, allowing the water stream to strike the inner wall of the vial to minimize formation of air bubbles. DO NOT RINSE THE SAMPLE VIALS BEFORE FILLING.
7. Fill the sample vial with a minimum of turbulence, until the water forms a positive meniscus at the brim.
8. Replace the cap by gently setting it on the water meniscus. Tighten firmly, but DO NOT OVERTIGHTEN.
9. Invert the vial and tap it lightly. If you see air bubbles in the sample, do not add more sample. Use another vial to collect another sample. Repeat if necessary until you obtain a proper sample.

V. ATTACHMENTS

None.

VI. KEY CHECKS AND ITEMS

- Check for possible sources of contamination.
- Check pH.
- Fill slowly, with as little turbulence as possible.
- Check for air bubbles.

WDCR826/022.WP5

SOP 9: VOC Sampling—Solids

The procedures covered in this SOP are included in SOP 3: Soil Sampling.

WDCR826/023.WP5

Table 1 OVM DATA LOGGER				
Lamp	Gas	Reading	Response Factor	Calibration Method
10.0 eV 10.6 eV	100 ppm isobutylene	100 ppm (RF=1.0)	Reset to 0.55	<ul style="list-style-type: none"> • 1.5 L/min regulator; use "T" tubing arrangement to connect to OVM. • Flush and fill tedlar bag with calibration gas; connect directly to OVM.
11.8 eV	100 ppm isobutylene	100 ppm (RF=1.0)	Reset to 0.68	<ul style="list-style-type: none"> • 1.5 L/min regulator; use "T" tubing arrangement to connect to OVM. • Flush and fill tedlar bag with calibration gas; connect directly to OVM.
<p>Note that the OVM is initially calibrated to respond "one-to-one" to isobutylene (RF=1.0). The RF should then be set to 0.55 (10.0 and 10.6 eV lamps) or 0.68 (11.8 eV lamp), which causes the OVM to mimic the HNU PID. The EPA total vapor action levels are based on HNU readings (Table 2-2). Once the RF value is reset, the calibration gas will read 55 ppm (10.0 and 10.6 eV lamps) or 68 ppm (11.8 eV lamp).</p>				

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Limitations: The instrument is sensitive to many organic and inorganic vapors/gases; it cannot be used as a qualitative instrument in unknown situations. It is strictly quantitative except when the nature of the contamination is known and the instrument has been calibrated to or a calibration curve has been generated for the contaminant being monitored. High humidity reduces sensitivity. Atmospheres with concentrations of vapors and gases about OVM detection limits will cause inconsistent instrument response.

Exposure Limits: Refer to HSP.

Action Levels: Refer to HSP.

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[illegible]

WDCR832/017.WP5/1

SOP 12: Water-Level Measurements

I. PURPOSE AND SCOPE

The purpose of this procedure is to provide a guideline for the measurement of the depth to ground-water in monitoring wells, where a second phase of floating liquid (e.g., gasoline) is not encountered. This SOP includes guidelines for discrete measurements of static water levels.

II. EQUIPMENT AND MATERIALS

A. Discrete Measurements of Static Water Level

- Electronic water level meter, Solinst or equivalent, with a minimum 150-foot tape; cable should have graduations in increments of 0.1 feet or less
- Engineering rule graduated in 0.01-foot increments

III. PROCEDURES AND GUIDELINES

A. Measurement Of Static Water Level

Verify that the unit is turned on and functioning properly. Slowly lower the probe on its cable into the well until the probe just contacts the water surface; the unit will respond with a tone or light signal. Sight across the top of the locking well casing adjacent to the measuring point, recording the position of the cable when the probe is at the water surface. The measuring point will be a standardized surveyed location on the top of each well casing, adjacent to the lock hasp, indicated by a notch, paint mark, or similar method. Measure the distance from this point to the next lower interval marker on the cable, and record the water level reading in the log book.

Measure and record the three following additional readings: (1) the depth of the well; (2) the depth from the top of the casing to the top of the well riser; and (3) the distance to the surface of the concrete pad or to ground. Measurements are to be taken with respect to the measuring point on the top of the well casing. The depth of well may be measured using the water-level probe with the instrument turned off.

Clean the probe and measuring tape with a paper towel sprayed with distilled water following a paper towel sprayed with 10 percent methanol as it is removed from the well.

IV. ATTACHMENTS

None.

V. KEY CHECKS AND PREVENTATIVE MAINTENANCE

A. Discrete Measurements of Static Water Level

Prior to each use, verify that the battery is charged by pressing the test button on the water-level meter. Verify that the unit is operating correctly by testing the probe in water. Leave the unit turned off when not in use.

WDCR826/026.WP5

SOP 13: Preserving Non-VOC Aqueous Samples

I. PURPOSE

To provide general guidelines for preserving aqueous samples.

II. SCOPE

Standard aqueous sample preservation procedures for non-VOC samples are provided.

III. EQUIPMENT AND MATERIALS

- Disposable eye droppers
- Clean beakers for transfer of small portions of chemical preservative
- pH paper strips (Range 0 to 14)
- Chemical preservatives, as appropriate
- Personal protection, as appropriate
- Clean outdoor or vented indoor area

IV. PROCEDURES AND GUIDELINES

1. Remove caps from sample containers to be chemically preserved in designated area. Add appropriate amount of chemical preservative to opened container. To determine the approximate amount of preservative which will be required, preserve a sample of potable water and calculate the volume of preservative required.
2. After adding the appropriate preservatives to the sample containers, cap containers tightly. Invert sample container a few times to mix.
3. After preserving all the sample containers and mixing, open the container and check the pH of the sample by pouring out a small quantity of the sample to a clean receptacle and dipping a pH indicating strip into the sample. Add more preservative to the sample to adjust the pH, if necessary repeating steps 1 and 2. When three times the amount of preservative used to preserve a sample of potable water has been added, record the pH and notify the ARCS Sample Manager that the sample could not be preserved.
4. Wrap, package, and ice samples according to the CLP User's Guide.

V. ATTACHMENTS

None.

VI. KEY CHECK ITEMS

WDCR826/027.WP5

SOP 14: Field Measurement of pH and Eh

I. PURPOSE AND SCOPE

The purpose of this procedure is to provide a guideline for field measurement of pH and Eh.

II. EQUIPMENT AND MATERIALS

- pH buffer solution for pH 4, 7, and 10
- Deionized water in squirt bottle
- pH/Eh meter, calibration sheet, and instructions
- pH and redox electrodes
- Beakers
- Glassware that has been washed with soap and water, rinsed twice with hot water, and rinsed twice with deionized water
- 4-mol KCl saturated with Ag/AgCl solution, electrode filling solution

III. PROCEDURES AND GUIDELINES

A. Calibration

Calibrate unit prior to initial daily use. There are no calibration procedures for the redox electrode. Calibrate with at least two solutions. Clean the probe according to the manufacturer's recommendations. Duplicate samples should be run once every 10 samples. The order of calibration solutions will be based on the instrument manufacturer's recommendation.

1. Place electrode in pH 7 buffer solution.
2. Allow meter to stabilize, and then turn calibration dial until a reading of 7.0 is obtained.
3. Rinse electrode with deionized water and place it in a pH 4 or pH 10 buffer solution.

4. Allow meter to stabilize again and then turn slope adjustment dial until a reading of 4.0 is obtained for the pH 4 buffer solution or 10.0 for the pH 10 buffer solution.
5. Rinse electrode with deionized water and place in pH 7 buffer. If meter reading is not 7.0, repeat sequence.

B. Procedure

1. Before going out into the field:
 - a. Check batteries.
 - b. Do a quick calibration at pH 7 and 4 to check electrode.
 - c. Obtain fresh calibration solutions.
 - d. Fill electrodes.
2. Calibrate meter using calibration procedure.
3. Pour the water sample into a clean beaker. If pH of soil is being measured, add roughly 5 ml distilled water to roughly 5 grams of soil, mix well, shake vigorously for 1 minute, let set for 10 minutes, and follow as below.
4. Rinse electrode with deionized water between samples.
5. Immerse electrode in solution. If flow-through cell is used, insert in cell. Make sure the white KCl junction on the side of the electrode is in the solution. The level of electrode solution should be one inch above sample to be measured.
6. Recheck calibration with pH 7 buffer solution after every five samples.

C. General

1. When calibrating the meter, use pH buffers 4 and 7 for samples with pH < 8, and buffers 7 and 10 for samples with pH > 8. If meter will not read pH 4 or 10, something may be wrong with the electrode.
2. Measurement of pH is temperature dependent. Therefore, buffers temperatures should be within about 2 degrees C of sample temperatures. For refrigerated or cool samples, use refrigerated buffers to calibrate the pH meter.

3. Weak organic and inorganic salts and oil and grease interfere with pH measurements. If oil and grease are visible, note it on the data sheet. Clean electrode with soap and water and rinse with distilled water. Then recalibrate meter.
4. Following field measurements, report problems and compare with previous data. Clean dirt off meter and inside case and store electrode in pH 4 buffer.
5. Accuracy and precision are dependent on the instrument used; refer to manufacturer's manual. Expected accuracy and precision are +/- 0.1 pH unit.
6. The redox electrode should be checked prior to beginning site work and when anomalous readings suggest that the probe is malfunctioning. The procedure for checking the redox electrode is as below:
 - a. Prepare solution A (0.1 M potassium ferrocyanide and 0.005 M potassium ferricyanide): weigh out 4.22 g reagent-grade $K_4Fe(CN)_6 \cdot 3H_2O$ and 1.65 g reagent-grade $K_3Fe(CN)_6$. Place in a 100 ml volumetric flask. Add about 50 ml distilled water and swirl to dissolve solids. Dilute to volume with distilled water.
 - b. Prepare solution B (0.01 M potassium ferrocyanide, 0.05 M potassium ferricyanide, and 0.36 M potassium fluoride): weigh out 0.42 g reagent-grade $K_4Fe(CN)_6 \cdot 3H_2O$, 1.65 g reagent-grade $K_3Fe(CN)_6$, and 3.39 g reagent-grade $KF \cdot 2H_2O$. Place in a 100 ml volumetric flask. Add 50 ml distilled water, and swirl to dissolve solids. Dilute to volume with distilled water.
 - c. Transfer solution A to a 150 ml beaker. Place electrode in the solution and wait until the reading stabilizes. The potential should be about 234 mV.
 - d. Rinse electrode and repeat the measurement with solution B. The potential should be about 66 mV greater in solution B than in solution A.

IV. KEY CHECKS AND PREVENTIVE MAINTENANCE

- Check batteries, have a replacement set on hand.
- Calibrate meter.
- Refer to operation manual for recommended maintenance.

SOP 15: Field Measurement of Specific Conductance and Temperature

I. PURPOSE AND SCOPE

The purpose of this procedure is to provide a general guideline for field measurement of specific conductivity and temperature of groundwater samples.

II. EQUIPMENT AND MATERIALS

- Conductivity meter and electrode
- Distilled water in squirt bottle
- Standard potassium chloride (KCl) solution (0.01 N)

III. PROCEDURES AND GUIDELINES

- A. Technical:** Detection limit = 1 umho/cm @ 25°C; range = 0.1 to 100,000 umho/cm
- B. Calibration:** Calibrate prior to initial daily use with standard solution. The standards should have different orders of conductance. Clean probe according to manufacturer's recommendations. Duplicates should be run once every 10 samples. Calibration procedure:
1. With mode switch in OFF position, check meter zero. If not zeroed, set with zero adjust.
 2. Plug probe into jack on side of meter.
 3. Turn mode switch to red line and turn red line knob until needle aligns with red line on dial. If they cannot be aligned, change the batteries.
 4. Immerse probe in 0.01 N standard KCl solution. Do not allow the probe to touch the sample container.
 5. Set the mode control to TEMPERATURE. Record the temperature on the bottom scale of the meter in degrees C.
 6. Turn the mode switch to appropriate conductivity scale (i.e., x100, x10, or x1). Use a scale that will give a midrange output on the meter.
 7. Wait for the needle to stabilize. Multiply reading by scale setting and record the conductivity.

8. If the conductivity meter does not perform an automatic temperature adjustment, the conductivity may be adjusted to 25°C using the formula:

$$G_{25} = G_T / [1 + 0.02 (T - 25)]$$

Where:

G_{25} = conductivity at 25°C, umho/cm
 T = temperature of sample, degrees C
 G_T = conductivity of sample at temperature T, umho/cm

The table below lists the values of conductivity that the calibration solution would have if the distilled water were totally nonconductive; however, even water of high purity will possess a small amount of conductivity.

Temperature °C	Conductivity (umho/cm)
15	1,141.5
16	1,167.5
17	1,193.6
18	1,219.9
19	1,246.4
20	1,273.0
21	1,299.7
22	1,326.6
23	1,353.6
24	1,380.8
25	1,408.1
26	1,436.5
27	1,463.2
28	1,490.9
29	1,518.7
30	1,546.7

9. Rinse the probe with deionized water.
- C. **Water Sample Measurement:** Pour the sample into a small beaker and place the probe in the sample. If flow-through cell is used, place probe in cell. Do not allow probe to touch container. Turn dial to appropriate conductivity scale. Note and record the reading. Turn dial to temperature setting. Note and record reading. Rinse the probe with deionized water when done.

- D. Soil Sample Measurement:** Mix a soil/distilled water sample in a ratio of 1:5, shake vigorously by hand for 1 minute, let set for 10 minutes. Use vacuum filtration to remove solids, measure conductivity of the liquid as you would for a water sample. Measure temperature with the conductivity cell in native sediment.

IV. ATTACHMENTS

- Conductivity meter calibration sheet

V. KEY CHECKS AND PREVENTATIVE MAINTENANCE

- Check battery.
- Calibrate meter.
- Clean probe with deionized water when done.
- When reading results, note sensitivity settings.
- Refer to operations manual for recommended maintenance.
- Check batteries, and have a replacement set on hand.

WDCR826/029.WP5

CONDUCTIVITY METER CALIBRATION SHEET

<u>Date</u>	<u>Time</u>	<u>Analyst Initials</u>	<u>Instrument Readings</u>		<u>Comments</u>
			<u>Uncalibrated @ EC=225</u>	<u>Calibrated @ EC=225</u>	

WDCR701/007.51

AR000966

SOP 16: Field Measurement of Dissolved Oxygen

I. PURPOSE

To provide general guidelines for the calibration and use of the Dissolved Oxygen (DO) meter.

II. SCOPE

This is a general guideline for the field use of a DO meter. For specific instructions, refer to the operations manual.

III. EQUIPMENT AND MATERIALS

- Operations manual
- A DO probe and readout/control unit with batteries
- Electrolyte solution (KCl dissolved in deionized water) and probe membrane

IV. PROCEDURES AND GUIDELINES

A. Calibration

Calibrate prior to initial daily use before any readings are taken. Clean probe according to manufacturer's recommendations.

1. Prepare DO probe according to manufacturer's recommended procedures using electrolyte solution.
2. In the off position, set the pointer to zero using the screw in the center of the meter panel.
3. Turn function switch to red line and adjust using red line knob until the meter needle aligns with red mark at the 31 degrees C position.
4. Turn function switch to zero and adjust to zero using the zero control knob.
5. Attach prepared probe and adjust retaining ring finger tight.
6. Allow 15 minutes for optimum probe stabilization (when meter is off or during disconnection of the probe).

7. Place probe in hollow stopper that is supplied for use with the YSI Calibration Chamber.
8. Place approximately 1/2 inch of deionized water into a 4-ounce, wide mouth screw cap bottle. Keep this bottle capped and with the DO meter.
9. Just before use, shake the bottle to saturate the water with air.
10. Remove cap, place probe in bottle keeping an air-tight seal around the rubber stopper. Swirl water around in the bottle while waiting for conditions to reach equilibrium.
11. Shield chamber from sun and wind to avoid temperature fluctuations during calibration.
12. Turn function switch to temperature and record temperature reading. Determine calibration factor for that temperature and altitude correction factor from tables supplied by manufacturer.
13. Multiply the calibration factor by the correction factor to get a corrected calibration value.
14. Turn function switch to appropriate ppm range and adjust the calibrate knob until the meter reads the corrected calibration value. Wait two minutes to verify calibration value. Re-adjust as necessary.

B. Procedure

1. Before going out into the field:
 - a) Check batteries
 - b) Obtain fresh electrolyte solution
 - c) Prepare DO probe
2. Calibrate meter using calibration procedure.
3. Place probe in water to be measured. If flow-through cell is to be used, place probe such that upstream entrance to flow-through cell is adjacent to probe membrane, with current flowing past and parallel to the surface of the membrane. If flow through cell is not used, the probe should be moved through the water at 1 ft/sec or use a probe with a built-in stirrer.
4. Allow sufficient time for probe to stabilize to water temperature and DO. Record DO meter reading.

V. ATTACHMENTS

None.

VI. KEY CHECKS AND ITEMS

- Battery check
- Calibration

WDCR826/033.WP5

SOP 17: Disposal of Fluids and Solids

I. PURPOSE AND SCOPE

The purpose of this guidance is to describe the procedures to dispose of hazardous fluid and solid materials generated as a result of the field operations performed at the site. This SOP does not provide guidance on the details of Department of Transportation regulations pertaining to the transport of hazardous wastes; the appropriate Code of Federal Regulations (49 CFR 171 through 177) should be referred to.

II. EQUIPMENT AND MATERIALS

A. Fluids

- 55-gallon steel drums
- Tools for securing drum lids
- Funnel for transferring liquid into drum
- Labels
- Marking pen for appropriate labels
- Seals for 55-gallon steel drums

B. Solids

- 55-gallon steel drums
- Tools for securing drum lids
- Plastic sheets
- Labels
- Marking pen for appropriate labels

III. PROCEDURES AND GUIDELINES

A. Methodology

Empty, clean new drums will be brought to the site by the drilling subcontractor for soil and groundwater collection and storage. The empty drums will be located at the field staging area and moved to drilling location as required. The drums will be filled with the drilling and well installation wastes, sampling purge water, soil sampling wastes, and personal protective equipment (PPE). They will then be capped, sealed, and moved to the onsite drum storage area by the drilling subcontractor. The full drums will separate types of wastes by media. The drums will be labeled as they are filled in the field and labels indicating that the contents are potentially hazardous affixed.

The contents of the solids drums will be sampled by the disposal subcontractor for TCLP toxicity, reactivity, corrosivity, and ignitability to determine the disposal requirements of the wastes.

B. Labels

Drums and other containers used for storing wastes from drilling operations will be labeled when accumulation in the container begins. Labels will include the following minimum information:

- Container number
- Container contents
- Origin (source area including individuals wells, piezometers, and soil borings)
- Date that accumulation began
- Date that accumulation ended

When laboratory results are received, drum labels will be completed or revised to indicate the hazardous waste constituents in compliance with Title 40 of the Code of Federal Regulations, Part 262, Subpart C.

C. Fluids

Drilling fluids generated during soil boring and groundwater discharged during development, aquifer testing, and purging of the monitoring wells will be collected in 55-gallon drums. When a drum is filled, the bung or lid will be secured tightly.

D. Solids

Most of the volume of solids to be disposed of is made up of soil cuttings from well and boring drilling.

Solids also will include plastic sheeting used for decontamination pads, tyveks, disposable sampling materials, and any other disposable material used during the field operations that appears to be contaminated. These materials will be placed in designated drums.

E. Storage and Disposal

The wastes generated at the site at individual locations will be transported to the drum storage area by the drilling services subcontractor.

Waste solid materials that contain hazardous constituents will be disposed of at an offsite location in a manner consistent with applicable solid waste, hazardous waste, and water quality regulations. Transport, sampling, and disposal will be performed by a commercial firm under subcontract.

When development and purging is completed, the water will be treated through a rented air stripper and discharged to the ground surface onsite. CH2M HILL will arrange for the required temporary discharge permits from PaDER.

IV. KEY CHECKS AND PREVENTATIVE MAINTENANCE

Check that representative samples of the drummed materials are obtained.

WDCR826/030.WP5

SOP 18: Field Rinse Blank Preparation

I. PURPOSE

To prepare a blank to determine adequacy of decon procedures and whether any cross-contamination is occurring during sampling.

II. SCOPE

The general protocols for preparing the rinse blank is outlined. The actual equipment to be rinsed will depend on the requirements of the specific sampling procedure.

III. EQUIPMENT AND MATERIALS

- Blank liquid (use HPLC grade water)
- Sample bottles as appropriate
- Gloves
- Preservatives as appropriate

IV. PROCEDURES AND GUIDELINES

- A. Decontaminate all sampling equipment that has come in contact with sample according to SOP 6.
- B. For volatiles, follow SOP 8. To collect the sample, pour blank water over one piece of equipment and into two 40-ml vials until there is a positive meniscus and seal vials. Note the sample number and associated piece of equipment in the field notebook.

For non-volatiles, one aliquot is to be used for equipment. For example, if a pan and trowel are used, place trowel in pan and pour blank fluid in pan such that pan and trowel surfaces which contacted the sample are contacted by the blank fluid. Pour blank fluid from pan into appropriate sample bottles.

Do not let the blank fluid come in contact with any equipment that has not been decontaminated.

- C. Document and ship samples in accordance with the procedures for other samples.

D. Collect next field sample.

V. ATTACHMENTS

None.

VI. KEY CHECKS AND ITEMS

- Wear gloves.
- Do not use any non-decontaminated equipment to prepare blank.
- Use HPLC grade water.

WDCR826/031.WP5

SOP 19: High Hazard Sample Shipping

I. PURPOSE AND SCOPE

The purpose of this procedure is to provide specifications on how suspected high hazard samples of soil, sediment, and water are to be shipped.

II. EQUIPMENT AND MATERIALS

- Sample containers
- Sample labels
- Chain-of-custody record forms
- Custody seals
- Sample tags
- Shipper airbill
- Coolers
- Vermiculite
- Ice
- Clear tape
- Strapping tape
- Waterproof pens
- Preservatives
- Droppers for preservatives
- In-line filters

III. PROCEDURES AND GUIDELINES

A. High-Concentration Samples

High-concentration samples are packaged using the techniques outlined in the ARCS III Sample Packing Memo with several additional restrictions. First, a special airbill including a Shipper's Certification for Restricted Articles is required. Second, "Flammable Liquid N.O.S." or "Flammable Solid N.O.S." labels must be placed on at least two sides of the cooler. Third, sample containers are packaged in metal cans with lids before being placed in the cooler, as indicated below.

- Place approximately ½ inch of vermiculite in the bottom of the can.
- Position the sample jar in the zip-loc bag so that the sample tags can be read through the plastic bag.
- Place the jar in the can and fill the remaining volume with vermiculite.

- Close the can and secure the lid with metal clips.
- Write the traffic report number on the lid.
- Place "This Side Up" and "Flammable Liquid N.O.S." (or "Flammable Solid N.O.S.") labels on the can.
- Place the cans in the cooler.
- Ship samples with "blue ice" inside the coolers.

B. Special Instructions for Shipping High Concentration Samples By Federal Express

1. Label cooler as hazardous shipment.
 - Write shipper's address on outside of cooler. If address is stenciled on, just write "shipper" above it.
 - Write or affix sticker saying "This Side Up" on two adjacent sides.
 - Write or affix sticker saying "ORM-E" with box around it on two adjacent sides. Below ORM-E, write NA#9188.
 - Label cooler with "Hazardous Substance, N.O.S." and "liquid" or "solid," as applicable.
2. Complete the special shipping bill for restricted articles.
 - Under Proper Shipping Name, write "Hazardous Substance, N.O.S." and "liquid" or "solid," as applicable.
 - Under Class, write "ORM-E."
 - Under Identification No., write NA No. 9188.
3. Ship samples with "blue ice" only inside coolers.

IV. ATTACHMENTS

None.

V. KEY CHECKS AND PREVENTATIVE MAINTENANCE

Check that trip blanks are included in coolers containing samples to be analyzed for VOCs. The Saturday delivery box on the carrier airbill should be checked, if appropriate. Double check paperwork to verify sample, analytical, and shipping information on sample labels, tags, chain-of-custody, shipping containers, and shipping bills. Check that the proper sample containers and preservatives are used.

WDCR826/032.WP5

SOP 20: Region III Sample Paperwork

EPA Sample Paperwork

December 14, 1993

The following pages contain information that was designed to assist you in completing the EPA Sample Paperwork correctly. In order for these checklists to be effective you need training on how to fill out the paperwork by the sample manager. Without the training, these checklists will not be as effective.

The intent of these checklists is to make you think about what you are doing. It is extremely easy to make a simple error, and following the checklists will help eliminate those errors.

You will notice as you read through the beginning pages that we talk about a lot of pre-sampling preparation of the paperwork: we strongly recommend you do this. It makes the sampling event go much smoother and you are not so pressed for time at the end of the day.

During the sampling event there are a few things you should keep in mind:

- Always follow the Sampling and Analysis Plan (SAP). The SAP is the Bible for all sampling events and its procedures should be followed as they are described.
- QC samples: make sure all of the QC requirements listed in the SAP are covered.
- Never call SMO with any questions at all. We are not allowed to talk to them unless we are giving them shipping information.
- Send copies of the completed paperwork to the Sample Manager (Julie Lovett/WDC) every night you ship samples (by Federal Express or FAX). CRL and SMO often have questions and we need to be able to look at the paperwork to answer these questions.
- **PLEASE CALL IN THE EVENT YOU ARE UNSURE ABOUT ANYTHING!! WE ARE HERE TO HELP.**
 - Sample Manager - Julie Lovett/WDC (x4361)
 - Site Manager - Site Specific
 - Secondary Sample Manager - Koumudi Ketkar/WDC (x4238)

AR000979

Sample Preparation Checklist

_____ If the sampling event has SAS analyses, have you had the SAS request written and submitted a minimum of 6 weeks before the sampling takes place?

Check the following 1 week before sampling:

Things to complete: _____

_____ Has the RAS lab been set up yet? (if applicable, call sample manager the Monday of the week before sampling to have the lab set up. Include total number of samples as well as the QC requirements).

_____ Review the Sampling and Analysis Plan (SAP).

_____ Where is the closest Federal Express office?

Do you have enough: _____

_____ Coolers (remember that organics and inorganics often go to different labs).

_____ Bottles (see enclosed list to get proper bottles for desired analyses)

_____ Preservative (see enclosed list to get proper preservative for desired analyses)

_____ Paperwork (tags, chain of custody forms, etc. - Call the Sample Manager - Julie Lovett - to get these forms if needed)

_____ Water-proof pens

_____ Filters? If you have a Metals analysis will you be filtering these samples?

_____ HPLC water

_____ Federal Express Forms

_____ Sample Equipment (pumps, meters, H&S, etc.)

_____ Trip blanks for VOA analysis? (if applicable)

Before going out into the field, it is a good idea to fill out the paperwork as much as possible, especially if you will be doing oversite (OS) work at the same time. Putting everything onto one form and then copying it over to new forms as those samples are collected and shipped out to the labs has been found to be extremely helpful, especially for people who are new to EPA paperwork, or have been away from it for a while.

If you begin to fill out the paperwork ahead of time, and you feel at all uncomfortable, please ask for a refresher training session. It doesn't take that long, and it will be a great help to you, so please take advantage of it. Even people who have done this before need to be refreshed from time to time. It is easy to make a simple mistake, so if you are unsure of what is supposed to be done, please ask for help.

The easiest way we have found to fill out the paperwork before the sampling event is by placing the corresponding tags and sticky labels in envelopes by location identifier. This will allow you to just grab the envelope for the specific location being sampled at that time. You can fill in just about everything on the paperwork. On the enclosed checklists for each form of paperwork, it notes what can and can't be filled out in advance. This is a huge time saver if all is filled out and correct before you go into the field. When filling out the paperwork ahead of time, make sure you also write up the information for all QC samples (MS/MSD, Field Blanks, Trip Blanks, etc.). The sample manager can assist you on preparing the paperwork ahead of time to make sure you are comfortable with this procedure for future sample activities.

AR000980

Frequent Paperwork Problems

Things To Avoid Doing

- Dissolved Metals analysis didn't get a separate CLP sample number from that of the Total Metals.

Whenever you take a total and dissolved metals sample, they **MUST** get separate CLP Sample Numbers. If they don't you will be writing a memo-to-file soon there after.

- Sampler didn't call SMO with shipping information or didn't call SMO before 3:00pm on Friday for Saturday deliveries.

Every night samples are shipped we need to call and fax SMO with the shipping information. SMO needs to know about Saturday deliveries before 3:00pm so they can make sure someone is at the lab to receive the samples.

- Tags incorrectly noted on the Chain of Custody form.

You need to be very careful when writing down these numbers. It is easy to transpose numbers or place them in the wrong box. This is a much to common problem that needs to be reversed, and that will be done only by being careful.

- MS/MSD samples not given the same CLP sample number.

Whenever you collect a sample and an MS/MSD, all volumes need to get the same CLP sample number. Example: You collect the sample, the MS and the MSD, this is triple the volume of normal. You will assign the same CLP sample number to 3 sets of samples. The reason, they are not separate samples, they are one in the same for the lab to be able to perform QC on them.

- Sample description for trip blanks, field blanks and equipment blanks not noted as Field QC/Rinsates.

EPA protocol calls for us to assign the description (Box 7 for the Organic and Inorganic paperwork, Box 6 for the SAS paperwork) for the Trip Blanks, Field Blanks and Equipment Blanks are called Field QC/Rinsates.

AR000981

Sample Paperwork Checklist

Inorganic Traffic Report/Chain of Custody

Fill out forms with available information:

- B ☐ Case No. (RAS No.)
- A ☐ Project Code (W.A. No.), Account Code. (You can get these from the sample manager, Julie Lovett/WDC)
- A ☐ Region No. (III), Sampling Co. (CH2M HILL), Sampler Name and Signature
- C ☐ Date Shipped, Carrier (Fed Ex), Airbill No.
- A ☐ Site Name, City, State, Site Spill ID (last 2 digits of account code)
- A ☐ Type of Activity (We will fill in: Lead: SF=Superfund or PRP - also fill in: Remedial: RIFS, RD, etc. depending on the site)
- B ☐ Lab Shipped to Address and "Attention-Sample Custodian" - no phone number in this box.
- A ☐ CLP Sample No. (sticky labels) from bottles. Make sure you use the Inorganic Traffic Report (ITR) labels. Note that filtered and unfiltered samples get separate CLP sample numbers. Also put a "*" next to the filtered sample.
- A ☐ A. Sample Description (from box 7) - Note that Trip Blanks, Field Blanks and Equipment Blanks are Field QC/Rinsates
- A ☐ B. Concentration ("low" is the majority of our sampling concentrations, refer to the site SAP for special procedures in the event of medium and high concentration samples)
- A ☐ C. Sample Type (composite or grab-fill in the one being used)
- A ☐ D. Preservative (from box 6) - See attached table for analyses and preservative requirements.
- A ☐ E. RAS Analysis - "X" the proper box for the desired analysis
- A ☐ F. Tag No. on Forms (can use a range if more than 1 tag is being used, **provided the tags run consecutively.** Example: 3-1263634 - 36)
- A ☐ G. Station Location (this is CH2M HILL's designated sample location identifier) Example: GW-2, GW-2DUP)
- C ☐ H. Date and Time of Sample Collection
- A ☐ I. Sampler Initials
- A ☐ J. Corresponding CLP organic Sample No. (if we have organic sampling at same location, put in the organic CLP sample no.)
- A ☐ K. Designated Field QC on Forms: Blanks "B" (field), Blanks "R" (Equip), Duplicate "D" also write the number next to the "D" that the sample is a dup of), Spike "S", Not a QC Sample "-", Perform. Eval. "PE" (**CH2M HILL rarely uses**)
- C ☐ Shipment for Case Complete? (If more sampling under this case, NO - if sampling totally complete, YES)
- C ☐ Page 1 of ___?
- A ☐ Sample Used for Spike and/or Duplicate (when we have an MS/MSD we must put in the CLP Sample No. of that sample in this box. This box should only be used for MS/MSD's, NOT field duplicates.)
- C ☐ Additional Sampler Signatures (Just another place for more samplers to sign)
- C ☐ Chain of Custody Seal Number (We don't have seal numbers in Region III, what we will use this box for is the filtered metals. When we do filter metals put the statement "** PLEASE DIGEST DISSOLVED" in this box. If not filtered just write in "N/A")
- C ☐ Relinquished Signature, Date and Time

A = Can be filled out before the sampling event.

B = If the lab assignment comes through from CRL early you will be able to fill this in before the sampling event.

C = Will be filled out in the field during the sampling event.

AR000982



United States Environmental Protection Agency
Contract Laboratory Program - Sample Management Office
PO Box 818 Alexandria, VA 22313
703 557-2490 FTS 557-2480

Inorganic Traffic Report & Chain of Custody Record

(For Inorganic CLP Analysis)

Case No.

SAS No.
(if applicable)

1. Project Code		Account Code		2. Region No.		Sampling Co.		4. Date Shipped/Carrier		SAS No. (if applicable)		Case No.	
Regional Information				Sampler (Name)				Airbill Number				7. Sample Description (Enter in Column A)	
Non-Superfund Program				Sampler Signature				5. Ship To				6. Preservative (Enter in Column D)	
Site Name				3. Type of Activity				Removal				1. Surface Water	
City, State				Site Spill ID				Remedial				2. Ground Water	
CLP Sample Numbers (from labels)				A - RAS Analysis				High only				3. Leachate	
A Enter # from Box 7				B Conc. Sample Type: Low Med High				D Preservative from Box 6				4. H ₂ SO ₄	
C Sample Type: Comp / Grab				E - RAS Analysis				Low Conc only				5. K ₂ Cr ₂ O ₇	
F Regional Specific Tracking Number or Tag Numbers				G Station Location Number				H Mo/Day/Year/Time Sample Collection				6. Oil (High only)	
I Sampler Initials				J Corresp. CLP Org. Samp. No.				K Enter Appropriate Qualifier for Designated Field QC				7. Waste (High only)	
Additional Sampler Signatures				Chain of Custody Seal Number				B - Blank S - Spike D - Duplicate H - Perform Eval N - Not a QC Sample				8. Other (Specify)	
Sample used for a spike and/or duplicate				Page 1 of									

CHAIN OF CUSTODY RECORD

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time	Received by: (Signature)	Date / Time
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time	Received by: (Signature)	Date / Time
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	Is custody seal intact? Y/N/None

Sample Paperwork Checklist
Organic Traffic Report/Chain of Custody

Fill out forms with available information:

- B ☐ Case No. (RAS No.)
- A ☐ Project Code (W.A. No.), Account Code. (You can get these from the sample manager, Julie Lovett/WDC)
- A ☐ Region No. (III), Sampling Co. (CH2M HILL), Sampler Name and Signature
- C ☐ Date Shipped, Carrier (Fed Ex), Airbill No.
- A ☐ Site Name, City, State, Site Spill ID (last 2 digits of account code)
- A ☐ Type of Activity (We will fill in: Lead: SF=Superfund or PRP - also fill in: Remedial: RIFS, RD, etc. depending on the site)
- B ☐ Lab Shipped to Address and "Attention-Sample Custodian" - no phone number in this box.
- A ☐ CLP Sample No. (sticky labels) from bottles. Make sure you use the OTR labels
- A ☐ A. Sample Description (from box 7) - Note that Trip Blanks, Field Blanks and Equipment Blanks are Field QC/Rinsates
- A ☐ B. Concentration ("low" is the majority of our sampling concentrations - Refer to the site SAP for special conditions in the event of medium or high concentration samples)
- A ☐ C. Sample Type (composite or grab-fill in the one being used)
- A ☐ D. Preservative (from box 6) - See attached table for analyses and preservative requirements
- A ☐ E. RAS Analysis - "X" the proper box for the desired analysis
- A ☐ F. Tag No. on Forms (can use a range if more than 1 tag is being used, **provided the tags run consecutively.** Example: 3-1263634 - 36)
- A ☐ G. Station Location (this is CH2M HILL's designated sample location identifier) Example: GW-2, GW-2DUP, etc.)
- C ☐ H. Date and Time of Sample Collection
- A ☐ I. Sampler Initials
- A ☐ J. Corresponding CLP inorganic Sample No. (if we have inorganic sampling at same location, put in the inorganic CLP sample no.)
- A ☐ K. Designated Field QC on Forms: Blanks "B" (field/trip), Blanks "R" (Equip), Duplicate "D" also write the number next to the "D" that the sample is a dup of), Spike "S", Not a QC Sample "-", Perform. Eval. "PE" - (CH2M HILL rarely uses)
- C ☐ Shipment for Case Complete? (If more sampling under this case, NO - if sampling totally complete, YES)
- C ☐ Page 1 of ___?
- A ☐ Sample Used for Spike and/or Duplicate (when we have an MS/MSD we must put in the CLP Sample No. of that sample in this box. This box should only be used for MS/MSD's, NOT field duplicates.)
- C ☐ Additional Sampler Signatures (Just another place for more samplers to sign)
- A ☐ Chain of Custody Seal Number (We don't have seal numbers in Region III, put "N/A" in this box)
- C ☐ Relinquished Signature, Date and Time

A = Can be filled out before the sampling event.

B = If the lab assignment comes through from CRL early you will be able to fill this in before the sampling event.

C = Will be filled out in the field during the sampling event.

AR000984



PO Box 818 Alexandria, VA 22313
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& Chain of Custody Record

1. Project

1. Project		2. Region No. Sampling Co.		3. Type of Activity		4. Date		5. Ship To		6. Preservative		7. Sample Description	
Regional Information		Account Code		Remedial		Airbill Number		Sampler Signature		(Enter in Column D)		(Enter in Column A)	
Non-Superfund Program		Site Name		SF		Remedial		Remedial		1. HCl		1. Surface Water	
Site Name		Site Spill ID		PRP		PA		RIFS		2. HNO3		2. Ground Water	
City, State				ST		SS		RA		3. NaHSO4		3. Leachate	
				FED		LSI		O&M		4. H2SO4		4. Rinsate	
								NPLD		5. Other		5. Soil/Sediment	
										6. Ice only		6. Oil (High only)	
										N. Not preserved		7. Waste (High only)	
												8. Other (Specify)	
CLP Sample Numbers (from labels)		A Enter # from Box 7		B Conc. Low Med High		C Sample Type: Comp/Grab		D Preservative from Box 6		E RAS Analysis		F Regional Specific Tracking Number or Tag Numbers	
										High only ARO/PCB TOX		G Station Location Number	
												H Mo/Day/Year/Time Sample Collection	
												I Sampler Initials	
												J Corresp. CLP Inorg. Samp. No.	
												K Enter Appropriate Qualifier for Designated Field QC	
												B = Blank S = Spike D = Duplicate H = Perform Eval N = Not a QC Sample	
Shipments for Case complete? (Y/N)		Page 1 of		Sample used for a spike and/or duplicate		Additional Sampler Signatures		Chain of Custody Seal Number					

CHAIN OF CUSTODY RECORD

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time	Received by: (Signature)	Date / Time
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time	Received by: (Signature)	Date / Time
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	Is custody seal intact? Y/N/none
Split Samples <input type="checkbox"/> Accepted <input type="checkbox"/> Declined					

EPA Form 9110-2 (Rev. 5-91) Replaces EPA Form (2075-7), previous edition which may be used
DISTRIBUTION:
Blue - Region Copy Pink - SMO Copy White - Lab Copy for Return to Region Yellow - Lab Copy for Return to EPA

AR000985

Sample Paperwork Checklist - SAS Packing List/Chain of Custody

Fill out forms with available information:

- B ☐ SAS No.
- A ☐ Project Code (W.A. No.), Account Code. (You can get these from the sample manager, Julie Lovett/WDC)
- A ☐ Region No. (III), Sampling Co. (CH2M HILL), Sampler Name and Signature
- C ☐ Date Shipped, Carrier (Fed Ex), Airbill No.
- A ☐ Site Name, City, State, Site Spill ID (last 2 digits of the account code)
- A ☐ Type of Activity (We will fill in: Lead: SF=Superfund or PRP - also fill in: Remedial: RIFS, RD, etc. depending on the site)
- B ☐ Lab Shipped to Address and "Attention-Sample Custodian" - no phone number in this box
- A ☐ Sample Numbers (SAS CLP numbers on sticky labels). Make sure you use the SAS labels.
- A ☐ A. Matrix (from box 6) - Note that Trip Blanks, Field Blanks and Equipment Blanks are Field QC/Rinsates
- A ☐ B. Concentration ("low" is the majority of our sample concentrations - Refer to the site SAP for special conditions in the event of medium or high concentration samples)
- A ☐ C. Preservative (from box 7) - See attached list for analyses and preservative requirements
- A ☐ D. Analysis (write out the name. Example: SULFIDE)
- A ☐ E. Tag No. on Forms (can use a range if more than 1 tag is being used, **provided the tags run consecutively**. Example: 3-1263634 - 36)
- A ☐ F. Station Location Identifier (this is CH2M HILL's designated sample station location. Example: GW-2, GW-2DUP, etc.)
- C ☐ G. Date and Time of Sample Collection
- A ☐ H. Sampler Initials
- A ☐ I. Designated Field QC on Forms: Blanks "B"(field/trip), Blanks "R"(Equip), Duplicate "D" also write the number next to the "D" that the sample is a dup of), Spike "S", Not a QC Sample "-", Perform. Eval. "PE" - (**CH2M HILL rarely uses**)
- C ☐ Shipment for SAS Complete? (If more sampling under this case, NO - if sampling totally complete, YES)
- C ☐ Page 1 of ___?
- A ☐ Sample Used for Spike and/or Duplicate (when we have a MS/MSD we must put in the CLP sample number of that sample in this box. This box should only be used for MS/MSD's, NOT field duplicates.)
- C ☐ Additional Sampler Signatures (Just another place for more samplers to sign)
- A ☐ Chain of Custody Seal Number (We don't have seal numbers in Region III, put "N/A" in this box)
- C ☐ Relinquished Signature, Date and Time

A = Can be filled out before the sampling event.

B = If the lab assignment comes through from CRL early you will be able to fill this in before the sampling event.

C = Will be filled out in the field during the sampling event.

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1. Project Information		Account Code		2. Region No. Sampling Co.		4. Date Ship		Carrier		6. Matrix (Enter in Column A)		7. Preserve (Enter in Column D)	
Regional Information		Sampler (Name)		Airbill Number		5. Ship To				1. Surface Water 2. Ground Water 3. Leachate 4. Field QC 5. Soil/Sediment 6. Oil 7. Waste 8. Other (Specify in Column A)		1. HCl 2. HNO ₃ 3. H ₂ SO ₄ 4. H ₂ SO ₄ 5. NaOH 6. Ice only 7. Other (Specify in Column D) N. Not preserved	
Non-Superfund Program		Sampler Signature		Long-Term Action		3. Purpose*		Early Action		SI		IFS	
Site Name		PRP		CLEM		PA		REM		RI		RD	
City, State		ST		OIL		O&M		NPLD		JUST		RA	
Site Spill ID		IFED		Analysis		E		F		G		H	
Sample Numbers (from labels)		A		B		C		D		Regional Specific Tracking Number or Tag Numbers		I	
Matrix Conc.: Low Med High		Sample Type: Preservative (from Box 6) Other:		Preservative (from Box 7) Other:		Sample(s) to be Used for Laboratory QC		Additional Sampler Signatures		Chain of Custody Seal Number(s)		J	
Shipment for SAS Complete? (Y/N)		Page of		Sample(s) to be Used for Laboratory QC		Additional Sampler Signatures		Chain of Custody Seal Number(s)		Chain of Custody Seal Number(s)		Field QC Qualifier B - Blank S - Spike D - Duplicate R - Retest PE - Perform Eval -- = Not a QC Sample	

Relinquished by: (Signature)		Date / Time		Received by: (Signature)		Date / Time	
Relinquished by: (Signature)		Date / Time		Received by: (Signature)		Date / Time	
Relinquished by: (Signature)		Date / Time		Received by: (Signature)		Date / Time	

CHAIN OF CUSTODY RECORD

DISTRIBUTION:		White - Region Copy Gold - Lab Copy for Return to Region		Yellow - SMO Copy Pink - Lab Copy for Return to SMO		EPA Form 9110-3		SEE REVERSE FOR ADDITIONAL STANDARD INSTRUCTIONS SEE REVERSE FOR PURPOSE CODE DEFINITIONS	
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AR000987

Sample Paperwork Checklist - Sample Tags

These can be filled out before the sampling event takes place. Fill in everything but the date and time, but just remember to fill these two things in before shipping off the samples.

- ___ Project Code (W.A. Number)
- ___ Station Location (This is the CLP Sample Number from the sticky labels)
- ___ Date of Sample Collection
- ___ Time of Sample Collection
- ___ Sample Type (Composite/Grab, "X" the proper box for the sample type)
- ___ Station Location (this is CH2M HILL's designated sample location identifier)
- ___ Sampler Signature
- ___ Preservative ("X" yes or no)
- ___ Analyses (put an "X" in the proper box of the analyses to be performed or write in the analyses name in the last box if not on the list)
- ___ Remarks (put the RAS or SAS Case Number and the preservative name here. Example: HNO₃, HCl, etc.) Also, if the sample is filtered note it in this box.

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★ GPO 706-155

Project Code	Station No	Month-Day Year	Time	Designate		Preservative: Yes <input type="checkbox"/> No <input type="checkbox"/>			
				Comp	Grab				
Station Location				ANALYSES					
				BOD Solids			Anions (TSS) (TDS) (SS)		
				COD, TOC, Nutrients					
				Phenolics					
				Mercury					
				Metals					
				Cyanide					
				Oil and Grease					
				Organics GC/MS					
				Priority Pollutants					
				Volatile Organics					
				Pesticides					
				Mutagenicity					
				Bacteriology					
				Remarks:					
Tag No. 3-1263650				Lab Sample No					

AR000989

Sample Paperwork Checklist - Shipping Logs

These are filled out after you have returned to the office after the sampling event is totally complete. Each RAS or SAS Case Number needs to have a separate shipping log created.

___ Page 1 of ___
___ Project Site Name
___ EPA Project Officer (RPM)
___ RAS No. or SAS No.
___ Project Site Leader (Site Manager)
___ Site Sample Coordinator (Julie Lovett)
___ Phone Numbers for above individuals
___ SAS Request Details - if applicable

- Write analyses type (Example: SULFIDE)
- Preservation - Write in name of the one used (Example: HNO₃, HCl, etc.) or a "-" if none.
- If this is a RAS shipping log, put a large "X" in this box.

___ QC Sample Information (In this column denote all QC information.
Example: Duplicate (i.e. Dup of #), Field Blank, Trip Blank, MS/MSD)
___ Concentration
___ Sample Phase (GW, SW, Soil, Sludge, Sediment)
___ Type of Request (ORG=Organic, INOR=Inorganic, or SAS)
___ EPA Sample No. (CLP Sample Numbers from sticky labels)

RAS:

___ Lab Name (All labs have abbreviations, some have similar names but are at different locations. If you don't have it ask the sample manager, Julie Lovett/WDC)
___ Date Shipped (not the date sampled, date shipped)
___ Data Received ("X" out items **NOT** requested)
___ Put a large "X" through the SAS columns

SAS:

___ Lab Name (All labs have abbreviations, some have similar names but are at different locations. If you don't have it ask the sample manager, Julie Lovett/WDC)
___ SAS Request Itemized (Write in "Sec (10)"; This refers to the above section where it gives the analyses and preservative)
___ Date Shipped (not the date sampled, date shipped)
___ Put a large "X" through the RAS columns

___ * Nothing is filled in for Data Received. This is for CRL.
___ Final Sampling (Located at the bottom of the page. Most likely will be "yes" since shipping logs will be filled out after the sampling event)
___ Final Shipping Date

AR000990

EPA SAMPLE SHIPPING LOG

PA OF

(1) (REQUIRED FOR ALL SAMPLES SENT THROUGH THE CONTRACT LAB PROGRAM)

PROJECT SITE NAME:

; EPA PROJ. OFFICER:

RAS NO. ; SAS NO.

; TASK OR SET NO.

PROJECT SITE LEADER:

; PHONE NO. ()

PROJECT SAMPLE COORDINATOR:

; PHONE NO. ()

SAS REQUEST (DETAILS REQUIRED)
(10)

QC SAMPLE CONC. SAMPLE TYPE OF REQUEST (ORG. NO. OR INORG.) SAS
INFORMATION (LOW/ MED./ (AQ/ SOL.)
AND/OR COMMENTS HIGH) (5) (4) (6) (6)

ORGANICS OR INORGANICS

LAB NAME DATE SHIPPED DATA RECEIVED (XX-OUT ITEMS NOT REQUESTED)

(1) (6) VOA BVA PEST ICOD METALS CN

Preservation

LAB NAME SAS REQUEST (ITEMIZE) DATE SHIPPED DATA REC'D
(11) (12) (15)

FINAL SHIPPING DATA:

REVISION

AR000991

Sample Paperwork Checklist - Miscellaneous

- ___ If the shipment of samples is delayed, canceled, or the sample count number increases/decreases, call the sample manager, Julie Lovett/WDC at 703/471-6405 (ext. 4361). Please give a reason for the delay/cancellation. CRL always needs a reason for delays/cancellations.
- ___ Did you double check SAS/RAS Numbers on the tags, labels and forms?
- ___ Did you write out complete sample numbers on each tag? Did you use preprinted sticky labels?
- ___ Did you assign the same CLP Sample No. to all volumes of any MS/MSDs?
- ___ Did you check tags, bottles, and forms for matching times and dates of sample collection?
- ___ Did you neatly cross-out any changes with one line, initial and date the change? **WHITE-OUT IS PROHIBITED!**
- ___ Did you put the airbill number on the chain of custody forms?
- ___ Are the lab copies of the forms, the last 2 sheets of the paperwork, protected in the cooler, taped to the cooler lid? The sample shipping log does not go in the cooler.
- ___ Is the ice packed in plastic bags to minimize leakage during shipping?
- ___ Are the tags securely attached to each sample bottle?
- ___ Is each container sealed in a plastic bag (when appropriate)?
- ___ Did you sign the "Relinquished by" box and fill in the date and time boxes?
- ___ Are the chain-of-custody seals taped on cooler and secured with clear tape over them to prevent accidental breakage of the seals?
- ___ Is the CH2M HILL return address written on the front outside corner of the cooler? If not, write it on there so the cooler will make its way back to CH2M HILL.
- ___ Did you write "Attention-Sample Custodian" on the Lab Address?
- ___ Are all samples being shipped PRIORITY OVERNIGHT? - No GSA airbills, use CH2M HILL airbills (bulk volume discount). Reason, GSA not guaranteed to get there in the AM the following day.
- ___ If Saturday delivery is required, the Federal Express form MUST be checked for Saturday delivery.
- * ___ Do not call labs or send them the sample shipping log
- ___ Call and fax EPA Sample Management Office (SMO) with complete sample information nightly. Many times you will reach an answering machine, you may leave the complete shipping information in a message. If you are unable to fax let SMO know this when calling in. This is the only thing we talk to SMO about. All other questions should go to the sample manager, Julie Lovett/WDC:

SAS Samples: Brian Moser 703/519-1472
SMO's SAS Fax Number: 703/683-0378

RAS Samples: Roger Nowakowski 703/519-1174
SMO's RAS Fax Number: 703/519-8626

See the next page for the shipping information we are required to inform SMO about.

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Sample Paperwork Checklist - Miscellaneous Continued

Information Needed:

- Your Name
- Sample Company (CH2M HILL)
- Region (III)
- Contact Phone Number (your office)
- Case/SAS Number
- Date Shipped
- Number of samples by concentration and matrix
- Carrier (Fed Ex) and Airbill Number
- Next planned shipment
- **Friday shipments for Saturday delivery MUST be called in to SMO by 3:00pm.**
- CRL does not accept shipments on Saturday unless authorized in advanced.

Things to do back at the office after the sampling event:

- Check over your paperwork to look for errors. It is better if CH2M HILL discovers them and corrects them before EPA comments on them. If you do find an error a memo-to-file needs to be written; this is discussed later.
- Fill out the shipping log. These forms need to be submitted before any analytical packages are received by CRL.
- Mail "REGION" copy of paperwork to:

Annette Lage
United States Environmental Protection Agency
Region III
Quality Assurance Branch
201 Defense Highway, Suite 200
Annapolis, MD 21401

This will be the white, green, or blue form as indicated on the bottom of the forms. Include the sample shipping log to CRL. Make sure you keep a copy of both the shipping log and chain of custody, and send a copy to the sample manager, Julie Lovett/WDC for the site sample files.

- Mail "SMO" copy of the paperwork to:

RAS - Roger Nowakowski
EPA Sample Management Office (SMO)
P.O. Box 818
Alexandria, VA 22313

SAS - Brian Moser
EPA Sample Management Office (SMO)
P.O. Box 818
Alexandria, VA 22313

This will be the yellow or pink form as indicated on the bottom of the forms. SMO DOES NOT get a copy of the shipping log.

AR000993

Sample Paperwork Checklist - Memo-to-File

In the event you have made a mistake and you are told you need to do a memo-to-file or you have discovered an error that requires a memo-to-file, there are some requirements as to the content of that memo. This memo needs to be written and submitted **IMMEDIATELY**. The following is a list of those items that are required to be in that memo so they will be able to easily identify that sample activity:

- ___ Case(RAS)/SAS Number
- ___ Overnight Carrier/Airbill Number
- ___ Date of Shipment
- ___ Chain-of-Custody Document Number
- ___ Sample Numbers
- ___ Tag Numbers
- ___ Sampling Dates
- ___ Analysis
- ___ Correction of the Error
- ___ Your Signature
- ___ * **DON'T PUT THE SITE NAME IN THE MEMO-TO-FILE UNLESS THE LAB WAS CRL.**

Once all this is included in the memo-to-file it needs to be distributed to certain individuals:

- ___ Custodian of Samples at the Laboratory (they get the original signed copy - Fed Ex'd)
- ___ EPA RPM for the specific site
- ___ Annette Lage/RSCC/CRL
- ___ SMO RAS or SAS Coordinator (depending on lab assignment)
- ___ SAS: Brian Moser RAS: Roger Nowakowski
- ___ CH2M HILL's Sample Manager, Julie Lovett/WDC (for the site sample files)

AR000994

**Sample Paperwork Checklist
Samplers Nightly Shipping Information**

Fill out forms with available information:

C	_____	Date of Shipment
C	_____	Number of samples shipped by analyses and matrix
C	_____	Shipment Complete (Yes or No)
A	_____	Your Name
A	_____	Sample Company
A	_____	Region
A	_____	Phone #
B	_____	Lab Name
B	_____	Lab (City, State)
B	_____	Case/SAS #
C	_____	Airbill #
C	_____	Next Shipment date

This form is written documentation of what samples you are sending. **NOTHING** else is to be written on this document (that includes requests for methods to be performed or anything that is not listed above). SMO still needs to receive a phone call. If you are unable to fax then notify SMO when you call that there will not be a fax'd copy sent. Make copies of this form when received so multiple shippings can be recorded. If you have any questions please call the sample manager, Julie Lovett/WDC (x4361).

A = Can be filled out before the sampling event.

B = If the lab assignment comes through from CRL early you will be able to fill this in before the sampling event.

C = Will be filled out in the field during the sampling event.

AR000995

BOTTLE TYPE, PRESERVATIVE AND HOLDING TIMES BY ANALYSIS

Aqueous

Analysis	Bottle Type	Preservative	Holding Time
Acidity	1 liter poly	None	14 days
Alkalinity	1 liter poly	None	14 days
Ammonia (NH3)	1 liter poly	H2SO4 pH<2	28 days
BNA/Semivolatiles	80oz amber	None	7 days
BOD5	1 liter poly	None	48 hours
Bromide (Br)	1 liter poly	None	28 days
CBOD5	1 liter poly	None	48 hours
Chemical Oxygen Demand (COD)	1 liter poly	H2SO4 pH<2	28 days
Chloride (Cl)	1 liter poly	None	28 days
Color	1 liter poly	None	48 hours
Cyanide	1 liter poly	NaOH pH>12	14 days
Dissolved Organic Carbon (DOC)	1 liter poly	H2SO4 pH<2	28 days
EP Tox	1 liter poly	None	None
Fluoride (F)	1 liter poly	None	28 days
Hardness	1 liter poly	HNO3 pH<2	6 months
Hexavalent Chromium (Cr+6)	1 liter poly	None	24 hours
Mercury (Hg)	1 liter poly	HNO3 pH<2	28 days
Metals	1 liter poly	HNO3 pH<2	6 months preserved
Nitrate (NO3)	1 liter poly	None	48 hours
Nitrite (NO2)	1 liter poly	None	48 hours
Nitrite+Nitrate (NO2+NO3)	1 liter poly	H2SO4 pH<2	28 days
Oil and Grease (O&G)	1 liter poly	H2SO4 pH<2	28 days
PCB/Pesticide	80oz amber	None	7 days
Phenol	1 liter poly	H2SO4 pH<2	28 days
Phosphorus (PO4)	1 liter poly	None	48 hours
Silica (Si)	1 liter poly	None	28 days
Sulfate (SO4)	1 liter poly	None	28 days
Sulfide	1 liter poly	None	7 days
Sulfite (SO3)	1 liter poly	None	Immediately
Total Dissolved Solid (TDS)	1 liter poly	None	7 days
Total Kjeldahl Nitrogen (TKN)	1 liter poly	H2SO4 pH<2	28 days
Total Organic Carbon (TOC)	1 liter poly	H2SO4 pH<2	28 days
Total Phosphorus (TP)	1 liter poly	H2SO4 pH<2	28 days
Total Solid (TS)	1 liter poly	None	7 days
Total Suspended Solid (TSS)	1 liter poly	None	7 days
Turbidity	1 liter poly	None	48 hours
Volatiles	3-40ml vials	HCL pH<2	14 days preserved

HCL - Hydrochloric Acid

NaOH - Sodium Hydroxide

HNO3 - Nitric Acid

H2SO4 - Sulfuric Acid

This list does not contain all possible analyses or acceptable bottle types. It was compiled from a table in the "CRL Sample Submission Guidelines (9/18/90)." In the event a desired analysis is not on the list, call the sample manager to get the proper bottle type and preservative.

AR000996

BOTTLE TYPE, PRESERVATIVE AND HOLDING TIMES BY ANALYSIS

Soil/Sediment

Analysis	Bottle Type	Preservative	Holding Time
Acidity	N/A	N/A	N/A
Alkalinity	N/A	N/A	N/A
Ammonia (NH ₃)	N/A	N/A	N/A
BNA/Semivolatiles	8oz glass	None	10 days
BOD ₅	N/A	N/A	N/A
Bromide (Br)	N/A	N/A	N/A
CBOD ₅	N/A	N/A	N/A
Chemical Oxygen Demand (COD)	8oz glass	None	28 days
Chloride (Cl)	N/A	N/A	N/A
Color	N/A	N/A	N/A
Cyanide	8oz glass	None	14 days
Dissolved Organic Carbon (DOC)	N/A	N/A	N/A
EP Tox	8oz glass	None	None
Fluoride (F)	N/A	N/A	N/A
Hardness	N/A	N/A	N/A
Hexavalent Chromium (Cr+6)	N/A	N/A	N/A
Mercury (Hg)	8oz glass	None	28 days
Metals	8oz glass	None	6 months preserved
Nitrate (NO ₃)	N/A	N/A	N/A
Nitrite (NO ₂)	N/A	N/A	N/A
Nitrite+Nitrate (NO ₂ +NO ₃)	N/A	N/A	N/A
Oil and Grease (O&G)	N/A	N/A	N/A
PCB/Pesticide	8oz glass	None	10 days
Phenol	8oz glass	None	28 days
Phosphorus (PO ₄)	N/A	N/A	N/A
Silica (Si)	N/A	N/A	N/A
Sulfate (SO ₄)	N/A	N/A	N/A
Sulfide	N/A	N/A	N/A
Sulfite (SO ₃)	N/A	N/A	N/A
Total Dissolved Solid (TDS)	N/A	N/A	N/A
Total Kjeldahl Nitrogen (TKN)	8oz glass	None	28 days
Total Organic Carbon (TOC)	N/A	N/A	N/A
Total Phosphorus (TP)	8oz glass	None	28 days
Total Solid (TS)	N/A	N/A	N/A
Total Suspended Solid (TSS)	N/A	N/A	N/A
Turbidity	N/A	N/A	N/A
Volatiles	2-40ml vials	None	14 days preserved

This list does not contain all possible analyses or acceptable bottle types. It was compiled from a table in the "CRL Sample Submission Guidelines (9/18/90)." In the event a desired analysis is not on the list, call the sample manager to get the proper bottle type and preservative.

AR000997